A star (✱) indicates that the Abstract deals with Apparatus and Instruments

JANUARY, 1940.

GENERAL PHYSICS.

ATOMIC AND MOLECULAR STRUCTURE.

1. Stability of elongated drop as model for nucleus. G. C. WICK. *N. Cimento*, **16**, *pp.* 229–241, *May*, 1939.—If the nucleus is treated as an incompressible liquid possessing a surface tension, it is known that with increasing atomic number the effect of the charge will outweigh the effect of the surface tension, so that the spherical shape will no longer be the most stable configuration. If one considers only ellipsoidal shapes it has been shown previously that for sufficiently heavy nuclei there exists a second minimum in the energy curve, corresponding to a very elongated ellipsoid. The stability of this shape under against deviations from the elliptical shape are now investigated. It is found that this configuration is unstable, and that there is no other stable configuration in its immediate neighbourhood. This leads to the supposition that, once the spherical shape ceases to be that of least energy, there will be no other stable configuration at all, except that in which the drop has broken up into two parts. R. P.

2. Electrocapillary theory of splitting of heavy nuclei by slow neutrons. J. FRENKEL. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 6, *pp.* 641–653, 1939. *In Russian.*—The disintegration of heavy nuclei (U, Th) by neutron capture into two roughly equal nuclei is interpreted as due to the instability of a highly charged liquid drop. From energetic considerations it is shown that a charged drop will split into two equal drops if the ratio γ of the electrostatic energy to the surface energy is greater than 2·17, and it is pointed out that γ for the known elements is indeed less than 2·17, but approaches close to 2·17 for U. The stability of a sphere against changes of shape to a rotation ellipsoid is next considered, and it is shown that the sphere is more stable than an ellipsoid of the same volume, provided $\gamma \geq 2$. The stability is then considered from a more general dynamical point of view, and finally the mechanism of disintegration due to excitation during the neutron capture is discussed. D. S.

3. Exchange forces between three heavy particles due to the meson exchange field. L. JÁNOSSY. *Cambridge Phil. Soc., Proc.*, **35**, *pp.* 616–621, *Oct.*, 1939.—On present views the interaction forces between nuclear particles are due to the meson field, i.e. to the possibility of a meson being emitted by one of the particles and re-absorbed by another. It is pointed out that the relative importance of multiple processes, in which a number of mesons take part, is determined by a parameter which in all probability is not small. If these higher processes contribute to any appreciable extent, the force between two particles will not only depend on the relative position and state of these particles, but will also be modified by the presence of others. This correction becomes of particular importance at close approach, and ought to be taken into account in the theory of nuclei. R. P.

4. Electron diffraction investigation of molecular structures of meso and racemic 2, 3-dibromobutanes. D. P. STEVENSON AND V. SCHOMAKER. *Am. Chem. Soc., J.*, **61,** *pp.* 3173–3176, *Nov.*, 1939.—From electron diffraction photographs it has been found that both racemic and meso 2, 3-dibromobutane have "trans" configurations with respect to the Br atoms, the Br-Br distance being 4.60 ± 0·03 Å. It has been shown further that a model for the structure of this pair of compounds, based on the known structure of isopropyl bromide, gives a theoretical scattering curve which is compatible with the photographs. Evidence for considerable torsional oscillation about the equilibrium "trans" configuration is presented. AUTHORS.

5. Limiting densities and molecular weights of O_2, CO_2, SO_2 and H_2S. Atomic weights for C and S. E. MOLES, T. TORAL AND A. ESCRIBANO. *Faraday Soc., Trans.*, **35,** *pp.* 1439–1452, *Dec.*, 1939.

See also Abstracts 30, 31, 109, 110, 170, 172, 183, 193, 228.

COLLOIDS.

6. Scattering of light by stearic acid hydrosols and by sodium stearate sols and gels. K. SUBBARAMAIAH. *Indian Acad. Sci., Proc. Sect. A*, **10,** *pp.* 289–295, *Oct.*, 1939.—Investigations carried out on stearic acid hydrosols demonstrate that the Schlieren effect exhibited by the sols is due to the presence of rod-like micelles and disappears on heating. The transition temperature is sharply defined, and in highly purified sols, is nearly the same as the melting point of solid stearic acid. In imperfectly purified sols however the transition occurs at a considerably lower temperature. The importance of the transition point as indicating a change from the solid to the liquid state of the micelles is pointed out. The phenomenon is not strictly reversible on cooling. Light scattering studies on stearic acid sols have established that their micellar size is appreciably large and increases continually on heating, due probably to partial coagulation by heat. The asymmetry in the shape of the micelles is high at low temperatures, and shows a fall at the transition point. At no state however do the particles become truly spherical. Studies on light scattering by sodium stearate sols have shown that on cooling a hot sol the micelles grow in size very rapidly and also exhibit enhanced asymmetry. The intensity of the scattered light also increases and becomes very high on gel formation. It is concluded that the micelles join together to form elongated chains which eventually lead to the formation of fibrils and a curdy opaque gel. The temperature of gelation is a function of the concentration of the sol. AUTHOR.

***7. Tensile properties of rubber compounds at high rates of stretch.** F. L. ROTH AND W. L. HOLT. *Bureau of Standards, J. of Research*, **23,** *pp.* 603–616, *Nov.*, 1939.—With the aim of determining whether the tensile properties of a rubber compound measured at high stretching rates offer any better indication of resistance to abrasive wear than the properties measured at the usual testing rates, a special apparatus was developed for stretching ring specimens to rupture by means of a falling weight. Tensile properties of the ring specimens were determined from a study of the position of the weight as a function of time. The position of the weight was recorded at equal time intervals on a paper tape, one end of which was fixed to the weight. The tape was pulled through a spark gap as the weight fell. The timing of the sparks was controlled by a tuning fork. Specimens were stretched to the point of rupture in about 0·5 to 0·75 sec. The work of extension was determined as a function of the elongation of the specimen from the instantaneous positions and corresponding speeds of the weight. Stress-strain relationships were then obtained from the work of extension. Tests were made on a range of cures of each of four rubber compounds. One of these was a pure gum compound, and each of the other three contained 25 volumes of a filler per 100 volumes of crude rubber. The three fillers used were channel black, soft black, and clay. A comparison of these data with similar data for a rate of stretch which lies in the range of speeds common to the usual routine tests fails to show that the tensile properties measured at the high stretching rates offer any better indication of resistance to abrasive wear than the properties measured at the usual testing rates. AUTHORS.

8. London-van der Waals force between two disc-shaped particles. G. P. DUBE AND H. K. DASGUPTA. *Comptes Rendus*, **209**, *pp*. 340–342, *Aug*. 7, 1939.—The systems, presenting the phenomenon of thixotropy, contain in general non-spherical particles (e.g. particles in colloidal solutions of V_2O_5 are in the form of rods, and those of Fe_2O_3 have the form of discs). In this paper the expression for the London-van der Waals energy is developed for the case where the particles are circular. Two cases are considered: (a) when the discs are in the same plane and (b) when they have their planes parallel and also perpendicular to the line of the centres. The results show that the range of the force considered is greater in case (a) than in case (b). J. J. S.

***9. Electro-ultrafiltration for industrial use.** D. v. KLOBUSITZKY. *J. Phys. Chem.*, **43**, *pp*. 823–824, *Oct.*, 1939.—A simple form of electrofilter, suitable for filtration of serum in quantities of about 5 l. is described. The serum is contained in a porcelain container of 5 l. size, the bottom of which is unglazed. A parchment bag is placed in this receiver, and supported by a basket-like support of glass bars. For the first filtration a small receiver is used also with an unglazed bottom. The lower portion of this receiver is coated with a solution of collodion in glacial acetic acid. The small receiver is connected with a vacuum pump. The electrodes consist of a platinum spiral anode and a perforated silver plate as cathode. By means of this apparatus the volume of previously dialyzed solutions of pseudoglobulin can be reduced to 10–15% in 24 to 36 hours, and the electrical conductivity diminished to 10 reciprocal ohms. F. J. B.

10. Solutions of paraffin-chain sulphonic acids as colloidal electrolytes. E. L. MCBAIN, W. B. DYE AND S. A. JOHNSTON. *Am. Chem. Soc., J.*, **61**, *pp*. 3210–3216, *Nov.*, 1939.—Conductivity measurements are presented for the homologous series of straight chain sulphonic acids from two to fourteen C atoms, together with data for density and refractive index. The data show the gradual transition from the behaviour of fully dissociated electrolytes for the lowest homologues through the intermediate members in higher concentration to the typical behaviour of colloidal electrolytes for the higher homologues. The latter approximate to complete dissociation in extreme dilution, then rather suddenly lose much of their conductivity through association of ion-pairs and ions to form colloidal particles of low conductivity, but after a well-defined minimum in moderately dilute solution, regain some of their conductivity through increasing formation of better-conducting or ionic micelles. This interpretation is in agreement with exact freezing-point and diffusion data for dodecyl-sulphonic acid. AUTHORS.

See also Abstracts 15, 61, 64, 146, 198, 213.

CRYSTAL STRUCTURE AND SPECIAL PROPERTIES.

11. Diffraction of X-rays by small crystalline particles. A. L. PATTERSON. *Phys. Rev.*, **56,** *pp.* 972–977, *Nov.* 15, 1939.—The problem of the diffraction of X-rays by small crystalline particles is discussed by the methods of Fourier analysis, and the calculation of the intensity of the X-ray scattering from a single particle is reduced to the evaluation of a simple Fourier transform. This approach leads immediately to the interference functions for the parallellepipedon and the octahedron as obtained by other authors. In addition, it makes possible the detailed discussion of the interference functions for the tetrahedron, the rhombic dodecahedron, the ellipsoid, and the elliptic cylinder. The method is shown to be applicable to any polyhedron. A simple method is also given for calculating the interference function and its integral breadth for specific directions of departure from the whole-numbered points. This is applied to obtain a partial discussion of the scattering from the tetrahexahedron and the trisoctahedron. [See following Abstract.] AUTHOR.

12. Scherrer formula for X-ray particle size determination. A. L. PATTERSON. *Phys. Rev.*, **56,** *pp.* 978–982, *Nov.* 15, 1939.—An exact derivation of the Scherrer equation is given for particles of spherical shape, values of the constant for half-value breadth and for integral breadth being obtained. Various approximation methods which have been used are compared with the exact calculation. The tangent plane approximation of v. Laue is shown to be quite satisfactory, but some doubt is cast on the use of approximation functions. It is suggested that the calculation for the ellipsoidal particle based on the tangent plane approximation will provide a satisfactory basis for future work. [See preceding Abstract.] AUTHOR.

13. Scattering of X-rays and electrons by crystals. Part III. J. M. BIJVOET AND C. H. MACGILLAVRY. *Ned. T. Natuurk.*, **6,** 17, *pp.* 301–314, 1939.—The dynamical theory of X-ray scattering led to the further conception of dispersion. The authors discuss the development of this idea along the lines of ordinary optical dispersion theory. In recent years interference phenomena have also been studied in which the atoms themselves are the radiating centres and the radiation concerned is the characteristic radiation of these atoms. This gives rise to the so-called Kossel and Kikuchi lines. These are discussed in some detail. Reproductions of photographs of such lines from a single crystal of Cu, a crystal of mica, and a crystal of zinc blende are given. [For Parts I and II see Abstract 4434 (1939).] G. G.

14. Electron energy levels in NaCl. S. R. TIBBS. *Faraday Soc., Trans.*, **35,** *pp.* 1471–1484, *Dec.*, 1939.—Slater's extension of the method of Wigner and Seitz is used to calculate the energy of the lowest conduction level in NaCl, and to determine the width of the first band of allowed conduction levels for the (100) direction. Attempts are described to ascribe to an electron at a vacant, negative-ion lattice point wave functions which give rise to energy levels which are in agreement with the experimental data on F-centres. AUTHOR.

15. Formation of the ordered condition in a binary alloy. V. ANASTASEVICH AND J. FRENKEL. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9,** 5. *pp.* 586–591, 1939. *In Russian.*—The authors calculate the speed of establishment of long-distance order in a binary alloy, and illustrate their theory by the example of the 50% ZnCu alloy, for which they find the maximum speed of ordering to occur at about 630° C. D. S.

16. Defect lattices in ternary alloys. H. LIPSON AND A. TAYLOR. *Roy. Soc., Proc. A*, **173**, *pp.* 232–237. *Nov.* 28, 1939.—In the Ni-Al system the solution of Al in the β NiAl (body-centred cubic) structure has been shown to be accompanied by an omission of Ni atoms from some of the lattice points. A study of the Cu-Ni-Al system shows that the omission of atoms begins at a line of constant ratio of valency electrons to atoms, and this is supported by evidence from the systems Fe-Cu-Al and Fe-Ni-Al. These results may be explained by the accommodation of electrons in the Brillouin zone. If the electrons fill the zone to a given energy level (which, in this case, is very near to the inscribed sphere of the zone) then the number of electrons per unit cell should be constant. It is shown that this is so for the Ni-Al system, but it is not true for the Cu-Ni-Al system, the number of electrons in the zone increasing as Cu is added. AUTHORS.

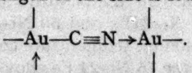
17. Magnetic test for superstructure in permalloy. S. T. PAN. *Phys. Rev.*, **56**, *pp.* 933–936, *Nov.* 1, 1939.—A search for indirect evidence of the existence of superstructures $FeNi_3$ and Fe_2Ni_2 by a magnetic method is described. In a preliminary test, it was found that annealing at a temperature around 450° C., for two to three days followed by slow cooling at a rate of about 40 deg. per hour increased the saturation magnetization by 3·9% in permalloy and 1·3% in Hipernik over the values found after the alloys were quenched from above 900° C. These increases were reproducible and the magnitudes depended somewhat on the exact way of heat-treatment. This makes it seem likely that at least partial order exists in the annealed alloys. Subsequent measurements taken after annealing at, and quenching from, different temperatures showed that the assumed ordering process takes place in temperature ranges 640° C.–400° C. and 800° C.–400° C. for the 76 Ni–24Fe and 50 Ni–50 Fe alloys, respectively. The saturation magnetization *vs.* temperature curves for the quenched and the slowly-cooled states of the 76 Ni–24 Fe alloy have also been taken. At a rather slow cooling rate, about 30 deg. per day from 700° C. to room-temperature, the increase in saturation value at room-temperature is 6·0%. All these results agree very well with those just reported by McKeehan and Grabe, Sucksmith, and P. Leech and C. Sykes. AUTHOR.

18. Structure of tellurite (TeO_2). T. ITO AND H. SAWADA. *Zeits. f. Krist.*, **102**, 1, *pp.* 13–25, 1939. *In English.*—The crystal structure of tellurite (TeO_2) was determined by X-ray methods, using oscillation photographs (MoKα radiation), Weissenberg photographs (CoKα radiation), and the ionization spectrometer (MoKα radiation). The space groups is V_h^{15} (*Pcab*), the unit cell having the dimensions $a = 5\cdot50$, $b = 11\cdot75$, $c = 5\cdot59$ Å, containing eight molecules of TeO_2. The structure similar to that of brookite (TiO_2), consists of deformed octahedra of O atoms surrounding Te. There are evidences for the existence of covalent linking of Te atoms. AUTHORS.

19. Calculated electrostatic potentials in the CaF_2 crystal. G. BRADISTILOV. *Zeits. f. Krist.*, **102**, 1, *pp.* 26–46, 1939.—For calculation of self-potentials of lattice points on the surface of the crystal, Ewald's method cannot be used. The author therefore applies Madelung's series for electrostatic potential [see Abstract 327 (1919)] and obtains the following values: Self-potential for an F$'$ ion in the outer surface (111) formed of F$'$ ions, 1·663 (8) $\sqrt{2}e/a$; self-potential for a Ca$^{\cdot\cdot}$ ion in the outer surface

(111) formed of Ca·· ions, 2·261 (4) $\sqrt{2}e/a$; electrostatic potential for the spaces immediately above the (111) plane that would be filled by F′ ions if crystal growth occurred, 0·1457 $\sqrt{2}e/a$; electrostatic potential for similar spaces, immediately above F′ ions, that would remain empty if crystal growth occurred, – 0·0702 $\sqrt{2}e/a$; self-potential in a non-twittering plane of F′ ions only, 1·8083 $\sqrt{2}e/a$; electrostatic potential for the spaces immediately above the (111) plane that would be filled by Ca·· ions if crystal growth occurred, 0·0433 $\sqrt{2}e/a$. D. R. H.

20. Structure of $KBr,CuBr_2$. A. SILBERSTEIN. *Comptes Rendus*, **209**, *pp*. 540–542, *Oct*. 2, 1939.—Tufts of black metallic needles of the double salt, 5 × 1 mm. are obtained by crystallization from a mixed solution with $CuBr_2$ in excess. The prismatic faces are found to be at angles of 65° and 115°. By use of a special camera and crystals covered with polysterol to combat their hygroscopic properties, Laue figures were obtained; $a = 4{\cdot}28$, $b = 14{\cdot}43$ Å, $c \sin \beta = 9{\cdot}2196$Å, $\beta = 108° \; 23'$, $c = 9{\cdot}71$ Å. giving a theoretical density of 3·92 against an observed value of 3·944. A space group of $C_{2h}^2 - P2_1/_m$ is suggested. Reflections from (h 0 l) are relatively intense if $(h + l) = 2n$, rare and feeble if $(h + l) = (2n + 1)$. D. R. H.

21. Structure of di-*n*-propylmonocyanogold. R. F. PHILLIPS AND H. M. POWELL. *Roy. Soc., Proc. A*, **173**, *pp*. 147–159, *Nov*. 28, 1939.—Di-*n*-propylmonocyanogold crystallizes in the orthorhombic system, $a_0 = 17{\cdot}06$, $b_0 = 22{\cdot}36$, $c_0 = 10{\cdot}0$ Å, space group P*ca*. There are 16 molecules of the formula $AuPr_2CN$ per cell. A Patterson analysis and Fourier syntheses on (001), and (010), two of these non-centrosymmetric, have been made and show that the true molecule consists of four of these units. The molecule is based on a square with gold atoms at the corners linked by CN groups along each side, and two propyl groups are attached to each gold atom. The length of the side is found to be 5·18 Å in accordance with the structure  $-\overset{|}{\underset{\uparrow}{\mathrm{Au}}}-\mathrm{C}\equiv\mathrm{N}\rightarrow\overset{|}{\underset{|}{\mathrm{Au}}}-$. The four covalencies of the auric gold atom are at right angles to each other and coplanar, and the bond length is close to 1·3 Å. Although the syntheses are based on eye-estimated intensities and the structure contains heavy atoms, the general positions of the largely overlapping propyl and cyano groups are clearly shown, especially in the centro-symmetric projection on (001). Spacial considerations are used to assign more definite sites to the lighter atoms in accordance with the projections, and the 144 atoms of the unit cell have been located. The bonds from the gold atoms to propyl groups all lie in the plane of the square but the rest of the propyl groups are arranged out of this plane in a complicated way. Intermolecular distances are not less than 3·4 Å. The low symmetry of the structure is attributed to the difficulty of packing an awkward-shaped molecule without leaving gaps. AUTHORS.

22. Crystallographic investigation of perchlorates of three carvone bases. O. GRÜTTER. *Zeits. f. Krist.*, **102**, 1, *pp*. 48–59, 1939.—Optical and goniometrical measurements are made on the perchlorates of the following bases, 1-dimethylamino–6–hydroxy–dihydrocarvone (I), 1–hydroxy–6–dimethylamino–dihydroxycarvone (II), 6–dimethylamino-carvone (III). The crystal data for the perchlorates of I, II and III are as follows; (I), monoclinic, $a : b : c = 1{\cdot}03 : 1 : 0{\cdot}73$, $\beta = 90°56'$, optic sign (—), n_γ // to y axis, $n_\gamma - n_\alpha = 0{\cdot}23$; (II), monoclinic, $a : b : c = 0{\cdot}89 : 1 :$

0·88, $\beta = 91°50'$, optic sign (—), $n_a//$ to y axis, $n_\gamma - n_a = 0·018$; (III), orthorhombic, $a:b:c = 0·79:1:0·60$, optic sign (+), $n_a//$ to y axis, $n_\gamma - n_a = 0·063$. The author discusses the crystallographic and chemical relationships between the three compounds. J. I.

23. Structure of succinic acid. H. J. Verweel and C. H. MacGillavry. *Zeits. f. Krist.*, **102,** 1, *pp.* 60–70, 1939. *In English.*—The cell dimensions of succinic acid are: $a = 5·10$; $b = 8·88$; $c = 7·61$ Å; $\beta = 133° 37'$. Space group $C_{2h}^5 — P2_1/a$. Two molecules per cell, with centre at 000 and $\frac{1}{2}\frac{1}{2}0$ respectively. Atomic parameters:

	x	y	z		x	y	z
C_1	0·021	0·036	0·258	O_1	—0·133	—0·080	0·253
C_2	0·056	0·067	0·081	O_2	0·167	0·142	0·422

The C – C bonds are single aliphatic bonds. The molecule is not flat, the COOH groups being turned out of the plane of the C-chain over an angle of 11°. Authors.

24. Examination of dental enamel by X-rays and the polarizing microscope. J. Thewlis. *Phys. Soc., Proc.*, **51,** *pp.* 992–1002, *Nov.*, 1939.—The phenomena of birefringence exhibited by human dental enamel are shown to be consistent with the crystalline arrangement previously suggested by the author on the basis of X-ray measurements. The main feature of this arrangement is the presence of two groups of apatite crystallites within each enamel prism. The hexagonal axes of one group are inclined to the prism direction at about 5°, and those of the other group at about 40°, the 5° group usualy being predominant. X-ray examination suggests that both groups of crystallites are also present in the interprismatic substance, and the optical properties of this material indicate that it contains, in general, a majority of the 40° crystallites. Author.

25. Oriented crystals of NaCl. N. Stulov. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9,** 5, *pp.* 630–633, 1939. *In Russian.*—Experiments are described in which oriented NaCl crystals grow from a super-saturated solution on metallic and amorphous plates. In all cases the trigonal axis was obtained perpendicular to the plane of the plate. This oriented growth was shown to be electrical in nature. D. S.

26. Growth of crystals from a stream of vapour. R. N. Haward. *Faraday Soc., Trans.*, **35,** *pp.* 1401–1413, *Dec.*, 1939.—Measurements are made on the rate of growth of a crystal mass from a vapour stream of known density. It is shown that in no case can the results be explained on the basis of a constant condensation coefficient. With salicylic acid the experiments are explained by a bimolecular process occurring in a mobile surface phase and this is in agreement with the crystal structure. Measurements are also made with mercuric iodide, anthracene, iodine and stannic iodide, and the results obtained with these substances suggest that thick layers of disarranged molecules may be built up on the surface of growing crystals. Author.

27. Structure and thermal properties associated with some hydrogen bonds in crystals. Part III. Further examples of the isotope effect. A. R. Ubbelohde. *Roy. Soc., Proc. A*, **173,** *pp.* 417–427, *Dec.* 18, 1939.—The effect on the lattice spacings of substituting D for H has been investigated for pentaerythritol, $CuSO_4\ 5H_2O$, $SrCl_2\ 6H_2O$, fumaric acid, KH_2PO_4, $NaHSO_4$, urea, and KHF_2. The main conclusion is that when the crystal structure contains hydroxyl bonds the isotope effect is small, and when it contains hydrogen bonds there is a marked expansion, which disturbs the lattice sufficiently to lead to the separation of potassium phosphate in a new crystal structure. The effect for KHF_2 does not suggest a short hydrogen bond in this compound. Short hydrogen bonds seem to require special resonance forces for their explanation. [For Parts I and II see Abstract 1473 (1939).] AUTHOR.

28. Classification of natural phosphates, arsenates and vanadates. H. STRUNZ AND J. SCHROETER. *Zeits. f. Krist.*, **102,** 1, *pp.* 71–78, 1939.—The classification is on the same lines as that proposed by Strunz for the silicates. The minerals, of which some 128 are dealt with, are first classified into anhydrous and hydrated. Each class is then subdivided according as " foreign " ions (OH, F) do or do not occur, and lastly the anhydrous divisions are further subdivided according as they do or do not contain cations showing 4- or 6-co-ordination. A separate class contains minerals in which the P, As or V forms with O groups other than the usual "tetrahedral island" (RO_4). [See Abstract 721 (1931).] C. A. S.

29. Determination of crystal-size from broadening of electron diffraction lines. T. SCHOON AND R. HAUL. *Zeits. f. phys. Chem.*, **44,** *Abt.B.* 2, *pp.* 109–126, 1939.—Applying a method first developed by Jones [see Abstract 2491 (1938)] for X-rays, the width of electron diffraction lines of a finely powdered specimen is confronted directly with the lines of a standard specimen ; thus the broadening of the lines due to particle size is isolated from the various other factors producing a finite width of the lines under given experimental conditions. However, the interpretation of such results is not quite unique, as there are different ways of approximating the interference function of the crystallites, and of allowing for the special experimental conditions. Four different formulæ are considered in this connection. Photographs of this kind were taken of samples of γ–Fe_2O_3, prepared at different temperatures, and the results were evaluated by the four different methods. In one case the values obtained for the grain size varied from 30 Å to 50 Å ; considering the fluctuation of particle size and shape within the powder and the effect of lattice distortions, the accuracy could not be very much higher. The agreement between the four methods is still better for smaller particle sizes (the region in which, due to their shorter wavelength, electrons are generally preferable to X-rays). The smallest particle size found, probably the limit of stability of the $\gamma - Fe_2O_3$ crystals, was ~ 17 Å, corresponding to crystallites composed of 8 elementary cells at the most. L. E. F.

See also Abstracts 67, 74, 143, 215, 233, 287.

DENSITY.

30. Apparent molal volumes of strong electrolytes in aqueous solutions. M. K. SRINIVASAN AND B. PRASAD. *Faraday Soc., Trans.*, **35,** *pp.* 1462–1465, *Dec.*, 1939.—The apparent molal volume of some mono-monovalent electrolytes has been studied from the standpoint of the Masson Redlich-Rosenfeld law : $\phi = \phi_0 + K\sqrt{c}.$ It is found that the values of K are generally of the same order (though not the same) for all electrolytes at the same temperature, except in the case of caesium nitrate at 25° C. where it surprisingly assumes a negative value. The following are the values of K : $K^{18}_{KCl} = 1 \cdot 73$, $K^{18}_{NaCl} = 1 \cdot 06$; $K^{25}_{KCl} = 2. \cdot 20$, $K^{25}_{CsNO_3} = -0 \cdot 26$,

$K^{25}_{CsI} = 1\cdot6$; $K^{35}_{KNO_3} = 0\cdot96$, $K^{35}_{NaNO_3} = 1\cdot27$, $K^{35}_{KCl} = 1\cdot5$, $K^{35}_{NaCl} = 1\cdot24$.

AUTHORS.

See also Abstracts 5, 55, 71, 206.

DIFFUSION AND OSMOSIS.

31. Coefficient of thermal diffusion of methane. A. O. NIER. *Phys. Rev.*, **56,** *pp.* 1009–1013, *Nov.* 15, 1939.—According to the theories of Enskog and Chapman, if a mixture of two gases is confined in a vessel in which there exists a temperature gradient a concentration gradient of the gases should also exist. The effect is confirmed for the isotopic gases $C^{12}H_4$ and $C^{13}H_4$ and the coefficient of thermal separation for methane has been determined. As the value found for this coefficient is somewhat less than that arbitrarily assumed by Furry, Jones and Onsager [see Abstract 2666 (1939)] in their theory on C isotope separation by thermal diffusion, the attainable separation factor for a given length column would be materially lower than that computed. AUTHOR.

See also Abstract 213.

ELASTICITY AND PLASTICITY.

32. Non-linear boundary problem of the buckled plate. K. O. FRIEDRICHS AND J. J. STOKER. *Nat. Acad. Sci., Proc.*, **25,** *pp.* 535–540, *Oct.*, 1939.—The buckling of a clamped circular plate under the action of a thrust uniformly distributed round the edge is solved by two methods, starting from von Kármán's equations, in which the effect of stretching of the middle surface is taken into account. For large thrusts it is found that the thrust changes rapidly to tension in a narrow annulus at the edge of the plate, and this narrow annulus can be treated in a manner analogous to the Prandtl treatment of the boundary layer in hydrodynamics.

W. G. B.

33. Elastic stresses in a plane system with reinforced hole. L. SOBRERO. *Accad. d'Italia, Mem.*, **10,** 4, *pp.* 105–141, 1939.—By use of *Airy* functions the author treats the problem theoretically, discussing governing conditions, conditions at the rim of the hole, expression of the functions, coefficients p,q,r,s, expressions for an arbitrary radius of hole, theoretical verifications of the formulæ deduced. By rigorous formulæ he obtains $A = -0\cdot231$, $B = -0\cdot379$, and, by numerical expression $-0\cdot229$ and $-0\cdot384$, respectively for $\sigma = \frac{1}{4}$, and reinforcement with height $a/3$, thickness $h/3$, internal radius $2\rho/3$. Particular cases for zero and rigid reinforcement are also considered ; for the latter $P_{min} = 0\cdot073\,P$, and $P_{max} = 1\cdot53P$ if $\sigma = \frac{1}{4}$, and $P_{min} = 0\cdot000$ and $P_{max} = 1\cdot50\,P$ if $\sigma = \frac{1}{8}$. In the second part of the paper an apparatus suitable for experimental work by use of photo-elasticity and a polarizer is described. Fair confirmation of theoretical formulæ is obtained ; p',q',r',s' are found to have values of $0\cdot211$, $-0\cdot035$, $-0\cdot035$, $-0\cdot0273$, and $0\cdot008$ respectively, with A,B,C,D equal to $-0\cdot223$, $-0\cdot312$, $-0\cdot075$ and $0\cdot264$. It seems therefore that the chief use of reinforcement is to conserve the plane section. D. R. H.

34. Stress systems in aelotropic plates. Part I. A. E. GREEN AND G. I. TAYLOR. **Part II.** A. E. GREEN. *Roy. Soc., Proc. A*, **173,** *pp.* 162–192, *Nov.* 28, 1939.—Equations which can be used for a system of generalized plane stress in a plate whose material has any kind of aeolotropy have been obtained recently by Huber. When the material has two directions of symmetry at right angles in the plane of the plate the equation for the stress function takes a comparatively simple form. In Part I solutions in polar co-ordinates of this equation are obtained which give single-valued expressions for the displacements, and these solutions are applied to the problem of an isolated force acting at an internal point of an infinite aeolotropic plate. The stress distributions due to such a force acting at a point of certain highly aeolotropic materials such as oak and spruce are represented by polar diagrams. In Part II formulæ are obtained for generalised plane stress systems in an infinite aeolotropic strip and also in a semi-infinite plate. In particular, a solution is given for the general problem of any force acting at any point either within or on the boundary of such plates. The stresses due to any distribution of force may be deduced by integration. When a force acts on the boundary of a semi-infinite plate the stresses may be deduced from our general results, but this case is dealt with independently by solving the problem of an isolated force at the vertex of a wedge. The method used here differs from that used by Michell who was the first to solve this problem. The stress distributions due to forces either within or on the boundary of a semi-infinite plate are illustrated numerically for a specimen of spruce wood which is highly aeolotropic. AUTHORS.

35. Point of elastic isotropy in rock-salt. A. BRJUKHANOV. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 6, *pp.* 722–724, 1939. *In Russian.* —Young's modulus was measured for rock-salt as a function of temperature in the (100) and (110) directions from 0° C. to 500° C., and a linear decrease found. The moduli became equal (*i.e.*, the crystal became elastically isotropic) at about 440° C. The method of measurement was to compare the (acoustic) frequency of natural vibration with that of a stretched wire. D. S.

36. Plastic deformation. N. BRILLIANTOV AND V. STARTZEV. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 5, *pp.* 592–594, 1939. *In Russian.*—Using optical and X-ray methods the distribution of twins through the volume of deformed NaCl crystals was investigated. It was found that twins go right through the crystal in the direction of the (110) plane. Twins were also found finishing inside the specimen and with an orientation varying along the twin. D. S.

See also Abstracts 7, 64, 75, 198.

HYDRODYNAMICS AND AERODYNAMICS.

37. Stability of two rows of vortices in a canal of finite width. H. K. DASGUPTA. *Comptes Rendus*, **209**, *pp.* 503–505, *Sept.* 25, 1939.—The stability of two rows of vortices of intensity I and — I, symmetrical and asymmetrical in a canal of definite and finite breadth is treated mathematically in this paper. The first portion of the investigation shows the instability of the symmetrical system and also of the asymmetrical. In spite of the instability of the system, however, a certain relative stability may be seen. Such a stability was found by Godefroy in a particular case. Further development of the calculations is promised in a future paper. J. J. S.

38. Calculation of useful surface of membranes of reduction valves. J. LICHTENS. *Comptes Rendus*, **209**, *pp.* 295–297, *July* 31, 1939. —The membranes treated are those which do not oppose any appreciable resistance to bending and which do not undergo sensible elastic lengthening for the pressures to which they are submitted. These membranes, fixed over a circular opening of radius R, have a form which allows them to take, under the influence of a force or of a pressure, a yielding, or to have a sagging with reference to their position of repose, or neutral position. In practice such a membrane is always provided in the central portion with a rigid disc, of radius, say γ, which increases its useful surface. Let the distance between the planes of the circles of radii R (where R is the radius of the whole surface) and γ be called a. The useful surface is defined as the ratio between the force P acting at the centre of the membrane and the pressure p which holds it in equilibrium. A formula has been found, the development of which is given in this paper, for the ratio K between the useful surface and the total surface, πR^2, of the membrane. The value found for this ratio, $P/p\pi R^2$,

$$= \tfrac{1}{3}\left(1 + \frac{r}{R} + \frac{r^2}{R^2} - a\left(1 - \frac{r}{R}\right)\sqrt{4 + 7\frac{r}{R} + 4\frac{r^2}{R^2}}\Bigg/\sqrt{5a^2_{\text{max.}} - 5a^2}\right).$$

This formula was found to agree with experiment. J. J. S.

39. Brittleness of liquids. M. KORNFELD AND M. RYVKIN. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 5, *pp.* 595–596, 1939. *In Russian.*—It was found that for velocities of impulsive deformation of about 20 m./sec. a liquid of viscosity 5×10^3 poise suffers brittle disruption. Results for velocities of 300 m./sec. are also described. The nature of the disruption was observed photographically. D. S.

KINETIC THEORY OF MATTER.

See Abstracts 199, 208, 260.

MATHEMATICAL METHODS AND THEORY OF MEASUREMENTS.

40. New proof of formulae for the generating function of Laguerre polynomials and other related formulae. K. S. K. IYENGAR. *Indian Acad. Sci., Proc. Sect. A*, **10**, *pp.* 181–185 *and* 211–216, *Sept.*, 1939.—A simplified proof of the expansion of the Laguerre polynomial of zero order in an infinite series is given. A proof of Mehler's formula involving only the recurrence formula for the Hermite polynomials and the differentiation of an infinite series term by term is also given. [See following Abstract.] G. C. McV.

41. Quantum mechanical interpretation of a result concerning Hermite polynomials. B. S. M. RAO. *Indian Acad. Sci., Proc. Sect. A*, **10**, *pp.* 217–219, *Sept.*, 1939.—It is shown that one of Iyengar's formulæ [see preceding Abstract] has an interpretation in the quantum-mechanical theory of the harmonic oscillator. G. C. McV.

***42. Mechanical integrator for product of two functions and computation of I.C.I. colour specification.** J. A. VAN DEN AKKER. *J.O.S.A.*, **29**, *p.* 501, *Nov.*, 1939.—A correction. [See Abstract 4218 (1939).]

See also Abstract 132.

MECHANICS, CLASSICAL.

See Abstract 242.

MECHANICS, QUANTUM.

43. Elementary particles in Eddington's relativistic quantum theory. G. DALLA NOCE. *N. Cimento*, **16**, *pp.* 305–323, *June*, 1939.—Report on Eddington's papers on the theory of elementary particles. R. P.

44. Relativistic wave equations for particles of arbitary spin in an electromagnetic field. M. Fierz and W. Pauli. *Roy. Soc., Proc. A*, **173**, *pp.* 211–232, *Nov.* 28, 1939.—The force-free theory of particles with arbitary spin values [see Abstract 983 (1939)] is generalized to the relativistic wave equations of such particles in an electromagnetic field, with a preliminary restriction to the *c*-number theory. The spins values 3/2 and 2 are treated in detail, and for the general case it is merely proved that consistent wave equations exist. The consistency of the system of field equations is attained by deriving them from a Lagrange function containing suitable additional terms which depend on new auxiliary quantities. All the differential equations of the field are derived by variation of the action integral and the vanishing of the auxiliary quantities in the absence of an external field is made to follow as a consequence of them. In the special case of zero rest-mass there exist identities between the equations, which are now invariant under a group of transformations which is the generalization of the group of gauge transformations in Maxwell's theory. In the particular case of spin 2, rest-mass zero, the equations agree in the force-free case with Einstein's equations for gravitational waves in general relativity in first approximation; the corresponding group of transformations arises from the infinitesimal co-ordinate transformations. Authors.

See also Abstracts 40, 41, 139, 202, 203, 205, 209, 240.

PRESSURE.

***45. High-speed oil-vapour condensation vacuum pumps.** M. Matricon. *J. de Physique et le Radium*, **10,** *pp.* 385–387, *Aug.*, 1939.—The author develops the concept of the "admittance" U of a connecting tube as the product of mean pressure and the volume at that pressure of the mass of gas passing per sec. through the same cross-section under a pressure of 1 bar; then $U = V_2 p_2/(p_1 - p_2)$. This value may be determined experimentally from the relation $V \log_e (p'_2/p_2)/(t' - t'')$, for the range p'_1 and p''_1. For low pressures Knudsen's relation $d^3 \sqrt{(2\pi)}/6l \sqrt{p}$ can be used. For air with $d = 14$ cm. and $l = 200$ cm., $A = 165$ dm.^{3}/sec., $U = 80$ dm.^{3}/sec. For a *short* orifice $A / \sqrt{(2\pi)p} = d^2 \sqrt{(2\pi)}/8 \sqrt{\rho}$, the real "admittance" of an ordinary tube is then given by $Y^{-1} = (d^3 \sqrt{(2\pi)}/6l\sqrt{\rho})^{-1} + (d^2 \sqrt{(2\pi)}/8 \sqrt{\rho})^{-1}$, *i.e.*, the total impedance is the sum of separated impedances due to its length and its extremities. Further, it is shown that for the normal pressure 2×10^{-2} mm. Hg of a source of ions, the pressure in the acceleration tube must be not less than 10^{-5} mm., in accordance with the known stability of tubes at this pressure. The ratio of 220 for the particular conditions considered is independent of the nature of the gas. At 0·28, 0·1 and 0·05 μ respectively, speeds of aspiration are given as 152, 154, 158 dm.^{3}/sec. for air, and 577, 585, and 600 for H_2. D. R. H.

***46. Two constant-pressure devices.** A. Clow and G. Shand. *Journ. Sci. Instruments*, **16,** *pp.* 354–355, *Nov.*, 1939.—Two manostats are described. The first, an all glass manostat, depends in its action on an all-glass valve of simple construction the essential part of which is a spherical standard joint polished until it does not pass more than 10 cm.^{3} of gas per hour. The valve is controlled by a relay and solenoid. The second device manostats by admitting air to the connected system when the vacuum exceeds a predetermined limit. A rubber diaphragm is pressed into contact with a capillary nipple by a column of Hg, but when the degree of vacuum exceeds the limit the weight of the atmosphere lifts the diaphragm and admits air to the system. S. W.

*47. **Thermal manometer for recording low absolute pressures.** R. S. Vincent and A. Simons. *Phys. Soc., Proc.*, **51,** *pp.* 1003–1009, *Nov.*, 1939.—An instrument for recording absolute pressures over the range from 0·1 to 100 mm. of Hg is described. The boiling point of Hg, boiling under the pressure to be measured, is recorded by means of a thermojunction. Authors.

See also Abstracts 38, 128.

RELATIVITY AND ETHER.

48. Mass and energy in the special theory of relativity. R. Lämmel. *Helv. Phys. Acta*, **12,** 6, *pp.* 511–518, 1939. *In German.*—The formula for the increase of inertial mass with velocity, characterizing the special theory of relativity, is deduced by means of elementary geometrical and mechanical considerations. In the deduction it is assumed that the world-line of the c.g. of two point-masses has the same objective significance as the world-line of a single point-mass and that therefore the same theorem for the addition of velocities must hold in the two cases. J. S. G. T.

49. Synchronizing "clocks" in a moving system by a connecting spindle. A. Eagle. *Phil. Mag.*, **28,** *pp.* 592–595, *Nov.*, 1939.—The author corrects an error in his method of synchronizing clocks [see Abstract 4347 (1938)] by means of connecting them together by rigid rotating rods. He also reaffirms his belief in a fixed ether. G. C. Mc V.

SOLUTION.

50. Apparent ionic volumes in aqueous solutions and electrostriction by ionic fields. Y. Kobayashi. *Hirosima Journ. Sci.*, **9,** *pp.* 241–267, *Aug.*, 1939. *In German.*—The paper is a theoretical discussion of apparent ionic volumes developed from the compressibility coefficients of water at extreme and so far impossible pressures. F. J. B.

51. Activity coefficients of strong electrolytes. P. van Rysselberghe and S. Eisenberg. *Am. Chem. Soc., J.*, **61,** *pp.* 3030–3037, *Nov.*, 1939.—The problem of expressing the activity coefficients of strong electrolytes as functions of a single parameter, the distance of closest approach between positive and negative ions or mean ionic diameter, is stated. The van der Waals or covolume terms in the activity coefficient formula are derived on the basis of a theory due to Ursell. A term proportional to the volume concentration and to the cube of the distance of closest approach, and another one proportional to the square of the volume concentration and to the sixth power of the distance of closest approach, are added to the Debye-Hückel expression for the logarithm of the activity coefficient. It is shown that only at high concentrations do the activity coefficients become sufficiently sensitive functions of the distance of closest approach to make the determination of this parameter really precise. Its determination by the method of least squares is described. The theory is applied to the alkali chlorides, bromides and iodides with remarkable success. A set of mean ionic diameters is obtained, and various remarks as to the extent of hydration, penetration of ions at contact, etc., are derived from a comparison of these diameters with the sums of the standard crystalline radii. Activity coefficients in 0·001 and 0·01 molar solutions are calculated with the weighted mean ionic diameters obtained at high concentrations. In 8 cases out of 15 comparison with experimental values is possible and shows more than satisfactory agreement. Authors.

52. Solubility of gases. Part II. Comparison of organic solvents with water. D. D. Eley. *Faraday Soc., Trans.*, **35,** *pp.* 1421–1432, *Dec.*, 1939.—While the energy of solution of a gas molecule is much the same in a series of organic solvents, it is appreciably more negative in water. It is suggested that the main part of this difference resides in the different energies required to form a cavity in the solvent in which the gas molecule is placed. A similar difference exists between the entropies of solution which arises from a difference in the entropies of cavity formation. A further discussion of the entropies and energies of solution is made, and a tentative co-ordination of the known facts of solution is attempted. The problem of solubility bears on that of the isothermal expansion of liquids. In both cases it is suggested that for organic solvents holes are made on the quasi-lattice points of the solvent. For water at room temperature structural modifications are possible which complicate the problem of cavity formation. Attention has been drawn to certain factors which could be neglected in a first account of the inert gases in water, but which would appear to be important for an account of the entropies of solution of a series of gases in an organic solvent. [For Part I see Abstract 4231 (1939).] Author.

SURFACE PROPERTIES.

53. Adsorption of non-polar gases on alkali halide crystals. W. J. C. Orr. *Roy. Soc., Proc. A*, **173,** *pp.* 349–367, *Dec.* 18, 1939.—An experimental technique sufficiently sensitive to measure accurately the very small amounts of non-polar gases which are adsorbed on alkali halide crystals is developed. Isotherms for A, O_2 and N_2 on KCl and CsI are described and the heats of adsorption as a function of the amount adsorbed are derived. For these systems a maximum occurs in the curve of the heat of adsorption plotted as a function of the amount adsorbed and this, it is shown, marks precisely the position at which a first monolayer is completed. The results are compared with theoretical calculations of the adsorption behaviour of A on KCl and CsI and very good general agreement is obtained. Probable explanations are advanced for specific deviations. In the range between the completion of a single monolayer and the bulk condensation of the gas an amount equal to three to four times that in the first layer is adsorbed. It is concluded that the molecules in this region tend to arrange themselves in layers rather than in localized aggregates. Author.

54. Adsorption of acetic acid by mercury. R. C. L. Bosworth. *Faraday Soc., Trans.*, **35,** *pp.* 1349–1352, *Dec.*, 1939.—The method of the maximum bubble pressure [see Abstract 127 (1939)] has been used to follow the changes in the surface tension of Hg produced by acetic and vapour. The change has been followed at a number of temperatures from 20° C. to 260° C. The presence of the acetic acid vapour depresses both the surface tension and its temperature coefficient, and even results in a reversal of the sign of this last property over certain ranges of temperature. Calculations of the amount of acid adsorbed has been carried out. This amount decreases with temperature, so that the adsorption is accompanied by an evolution of heat. This heat of adsorption proves to be $6 \cdot 1$ kg.cal. for close-packed films and rises to $8 \cdot 3$ kg.cal. as the surface concentration is decreased to $0 \cdot 25 \times 10^{14}$ molecules per cm.^{2} Author.

55. Adsorption of gases on vitreous silica. G. A. R. Hartley, T. H. Henry and R. Whytlaw-Gray. *Faraday Soc., Trans.*, **35,** *pp.* 1452–1461, *Dec.*, 1939.—Describes an experimental study of the adsorption of a series of gases on clean surfaces of vitreous silica. Comparison with the results obtained by Moles show that the adsorption even of easily liquefiable gases on silica is for the majority of gases much smaller than on glass surfaces. As a result of this investigation it is believed that the uncertainties due to adsorption effects in determinations of compressibilities, coefficients of expansion and densities of gases could be reduced to negligible proportions by the use of silica vessels. The results also confirm the reliability of the limiting pressure method for comparing exact molecular weights of gases with the silica buoyancy microbalance. H. B.

56. Effect of CO_2 on the surface tension of Hg. R. C. L. Bosworth. *Faraday Soc., Trans.*, **35,** *pp.* 1353–1354, *Dec.*, 1939.—The surface tension of Hg in pure dry air containing various proportions of purified CO_2 was determined by the drop-weight method. With increasing content of CO_2 the surface tension at first falls to a minimum at about 3% CO_2 and thereafter rises at first moderately sharply and later more and more slowly, the value in pure CO_2 being about 1½% lower than in air. This type of surface tension—concentration curve indicates strong positive adsorption of CO_2 below 3% CO_2 content, zero adsorption at 3%, and negative adsorption at all higher values. Strong positive adsorption being observed from all air-CO_2 mixtures, presumably the Gibbs layer on Hg is thick enough to contain O_2 (or N_2) in excess of the amount of CO_2 already found. P. H. B.

57. Surface tensions of two-phase liquid systems containing benzene. J. W. Belton. *Faraday Soc., Trans.*, **35,** *pp.* 1354–1361, *Dec.*, 1939.—The surface tensions of the liquid phases of the systems (*a*) benzene-carbon disulphide-water, (*b*) benzene-aceticacid-water have been measured. The Gibbs equation is applied to the data, and the relationship between the amount of solute adsorbed at the liquid-vapour and liquid-liquid interfaces is discussed. It is shown that the adsorption of acetic acid at the aqueous phase-vapour interface may be calculated by an indirect method, and that it is almost equal to that at the liquid-liquid interface. Author.

58. Structure of thin layers formed on single crystals. Part II. R. Uyeda. *Phys. Math. Soc. Japan, Proc.*, **21,** *pp.* 517–523, *Sept.*, 1939.—Thin films of MoO_3 were formed by subliming MoO_3 in a vacuum on the cleavage face of molybdenite or polished surfaces of metals at a temperature *t* and their structure was investigated by the method of cathode-ray diffraction. It was found that the structure depends upon the nature of the base and the temperature *t* as summarized in the following table :—

	20°–100° C.	100°–350° C.	100°–450° C.
Molybdenite	(Diffuse rings)	[MoO_3] fibre structure	MoO_2 single crystal
Au		[MoO_3] almost at random	MoO_2 almost at random
Ni			
Cu		MoO_2 almost at random	

The substance denoted by [MoO_3] in the table is supposed to be an intermediate oxide between MoO_2 and MoO_3. The substance which produced the diffuse rings has not been identified. In the pattern of MoO_2 single crystal, extra spots were observed and they are interpreted as due to a superstructure of MoO_2 crystal. [For Part I see Abstract 4361 (1938).] AUTHOR.

59. Electron diffraction study of the corrosion of iron. S. MIYAKE. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers. No.* 931, *pp.* 363–370, *Oct.*, 1939.—The process of corrosion taking place on iron immersed in water or an aqueous salt solution was studied by means of electron diffraction. Besides the well-known rust products such as γ-$Fe_2O_3 \cdot H_2O$, α-$Fe_2O_3 \cdot H_2O$, γ-Fe_2O_3, the presence of an unknown substance was revealed. This " two-ring substance " is assumed to be an intermediate between γ-$Fe_2O_3 \cdot H_2O$ and γ-Fe_2O_3. It is to be noted that the film of the " two-ring substance " has in many respects a very close resemblance to the film assumed by Bengough in his " film-distribution theory". AUTHOR.

60. Organic parachors. Part IV. O. R. QUAYLE, K. OWEN AND E. M. BEAVERS. *Am. Chem. Soc., J.*, **61,** *pp.* 3107–3111, *Nov.*, 1939.—The densities, surface tensions and parachors of 16 tertiary chlorides have been determined. The parachors show a decrease with temperature of approximately 0·2% per 10 deg. rise in temperature. The effect of substitution in trimethylchloromethane has been found to be of the same order as that with trimethylcarbinol. Values for the individual CH_2 groups in the tertiary chlorides have been determined and found to be of approximately the same value as those obtained for the corresponding CH_2 groups in the tertiary carbinols. The similarity of the values obtained for the chlorides and alcohols indicates that association is not an important factor in the parachor values of the alcohol series. The values for the tertiary branching give closer agreement between the calculated and observed values than those previously used. [For Parts II and III see Abstract 2371 (1939).] AUTHORS.

61. Clay films. E. A. HAUSER AND D. S. LE BEAU. *J. Phys. Chem.*, **43,** *pp.* 1037–1048, *Nov.*, 1939.—Coherent, self-supporting films produced from colloidal hydrous aluminium silicates are used as a new condition of colloidal matter to study different reactions. The influence of the original particle size on water retention by the deposited film is discussed and correlated with our present ideas of the structure of montmorillonite. The influence of higher temperatures on the colloidal clay micelle is explained. The influence of electrolytes on films is demonstrated, and the differences in the behaviour of clay in film and sol form discussed. A theory is advanced to explain water resistance. The presence of Mg in the treating bath is pointed out and correlated with previous findings. The film structure is discussed on the basis of X-ray studies. Photomicrographs of films heated to different temperatures and films submitted to electrolyte treatment are given in support of the views presented. AUTHORS.

62. New method of spreading monolayers of albumin and lipoid-albumin mixtures. S. STÄLLBERG AND T. TEORELL. *Faraday Soc., Trans.*, **35,** *pp.* 1413–1416, *Dec.*, 1939.—A 60% aqueous solution of propyl alcohol (normal or *iso*-) containing 0·5 molar Na-acetate has been employed as a solvent for both albumin and lipoids. Such a solution can be used for spreading monolayers of albumins, lipoids or mixtures thereof. AUTHORS.

63. Surface films of heat-denatured serum albumin. S. STÄLLBERG. *Faraday Soc., Trans.*, **35,** *pp.* 1416–1420, *Dec.*, 1939.—Surface films given by " native " and heat-denatured serum albumin have been investigated. Denaturation was found to be accompanied by a marked increase in area (*c.* 15%), changes in the compressibility, rigidity and the "gelation-point," but by no significant alteration in the apparent dipole moment. AUTHOR.

64. Thin protein membranes. O. GATTY AND J. H. SCHULMAN. *Faraday Soc., Trans.*, **35,** *pp.* 1510–1513, *Dec.*, 1939.—Stable protein multilayers can be stretched across fine mesh wire gauzes and silk. The resulting films are impermeable to isamine blue but sufficiently permeable to NaCl for 200 monolayers to hold a diffusion potential different from that in the absence of membrane at a value which decays with a half life of 20 min. Interposing some forty layers of spread amphibian eggs between the protein layers does not appreciably affect the properties of the membranes which were somewhat variable. It appears that the diffusion constant of NaCl is lower in the membrane than in water and that the partition coefficient leads to lower salt concentrations in the membrane. Amphibian eggs when spread give lipoprotein films, some of whose spacings can be determined from X-ray data. AUTHORS.

65. Contact potential of iodine film on tungsten. M. J. COPLEY AND R. W. SPENCE. *Am. Chem. Soc., J.*, **61,** *pp.* 3027–3030, *Nov.*, 1939.—Evidence is presented that I_2 forms a stable film on W. Above 1 250°K. the film evaporates at a noticeable rate, but flashing to 2 000°K. is required for its complete and rapid removal. The contact p.d. at room temperature between a clean W surface and an I_2 coated W surface was found to be $-0{\cdot}91$ V. The magnitude of the dipole moment of the adsorbed atoms in the complete film is estimated as 1·0 Debye unit. AUTHORS.

66. Electrical characteristics of molecular films. F. J. NORTON. *Am. Chem. Soc., J.*, **61,** *pp.* 3162–3168, *Nov.*, 1939.—Surface potentials can be put on X or Y stearate multi-films by applying a voltage while the films are in a conducting medium such as air ionized by Po. With voltage off, the films lose their charge exponentially. The coulombs represented by the area under the automatically registered discharge curve agree with Langmuir's equation which calculates potential resulting from surface charges. The slow leakage of charge from X films left in ordinary air can be explained by the natural electrical conductivity of air. Surface potentials were found to exist on calcium stearate X films deposited on glass. AUTHOR.

67. Surface reaction between oxonium ions and mica. R. S. BRADLEY. *Faraday Soc., Trans.*, **35,** *pp.* 1361–1366, *Dec.*, 1939.—Sheets of freshly cleaved mica immersed for short times in solutions of low H-ion concentration do not give the complete orientation of crystals of NH_4I obtained with unattacked mica, but give a mixture of oriented tetrahedra and unoriented cubes, the proportion of the latter increasing with time of immersion in the acid solution. The results are interpreted in terms of surface attack by oxonium ions. AUTHOR.

See also Abstract 287.

TIME.

***68. Accurate hard-valve counter chronograph.** F. L. UFFELMANN. *Phys. Soc., Proc.*, **51,** *pp.* 1028–1033, *Nov.*, 1939.—A 10-unit scale-of-two circuit is used to count the number of periods of a 100-kc./sec. crystal-controlled oscillator in the required time interval. The result is given instantly, correct to one period of the oscillator; the maximum error is 10^{-5} sec. [See Abstracts 1707 and 3205 (1938).] AUTHOR.

VISCOSITY AND FRICTION.

69. Precision determination of viscosity of air. J. A. Bearden. *Phys. Rev.*, **56**, *pp.* 1032–1040, *Nov.* 15, 1939.—The rotating cylinder method has been used for making a precise determination of the viscosity of air. The inner cylinder was rotated, which made possible a higher degree of accuracy in the construction of the apparatus and in its adjustment than was possible if the outer cylinder had been rotated. Two rotating cylinders were used, and the error introduced into the viscosity by inaccuracies in machining and measurements was for the best cylinders $2 \cdot 01 \times 10^{-3}\%$. Torsion wires were studied in detail and a method of treatment used which removed the defects of zero drift and variability of torsion constant for static and dynamic conditions. A precision telescope and calibrated comparator were used in measuring the angular deflection of the deflecting cylinder. The timing and driving mechanism consisted of a tuning-fork controlled d.c. motor whose speed was constant within one part in 10^6, as checked by N.A.A. time signals. The viscosity of air at 20·00° C. is $(1819 \cdot 20 \pm 0 \cdot 06) \times 10^7$ c.g.s. unit. [See following Abstract.] Author.

70. Viscous force between almost-coaxial cylinders. D. R. Inglis. *Phys. Rev.*, **56**, *pp.* 1041–1044, *Nov.* 15, 1939.—For the sake of an estimate of the errors which might enter the measurements of the viscosity of air [see preceding Abstract] by accidental misalignment, the problem of the viscous flow between almost-coaxial cylinders, one of which is rotating, is treated theoretically. The torque exerted on the stationary cylinder is calculated by means of a series expansion which treats both the curvature and the eccentric displacement as small. It is shown incidentally that a calculation in the theory of lubrication in the previous literature, which neglects the curvature altogether, is not correct in all its steps although it happens to lead to a correct result for the torque. Author.

71. Viscosity and density of aqueous solutions of $BaCl_2$, $MgCl_2$, $CoCl_2$ and $NiCl_2$. A. S. Chacravarti and B. Prasad. *Faraday Soc., Trans.*, **35**, *pp.* 1466–1471, *Dec.*, 1939.—The viscosity of $BaCl_2$, $MgCl_2$, $CoCl_2$ and $NiCl_2$ solutions and apparent molal volumes of these electrolytes in aqueous solutions have been measured at 35° C. Viscosity of all the solutions obeys the Jones and Dole equation. The calculated values of A (0·015, 0·017, 0·018) for $BaCl_2$, $MgCl_2$ and $CoCl_2$ agree with the experimental values (0·018, 0·017, 0·016). In the case of $NiCl_2$, the divergence is quite appreciable; calculated 0·018, experimental 0·028. The apparent molal volumes are found to be linear functions at $\sqrt{c}$, at least for concentrations greater than 0·025 moles/litre. For lower concentrations, some of the deviations seem to be real. The value of K in the equation $\phi = \phi_0 + K\sqrt{c}$ should be the same for all the electrolytes used, but it is not so. Authors.

72. Low-temperature viscosity measurements. M. Veksler. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 5, *pp.* 616–621, 1939. *In Russian.*—The viscosities of a number of organic liquids were measured with a disc viscometer from room temperature down to − 150° C. It was found that the low temperature results did not support any of the proposed empirical or theoretical formulæ (*e.g.*, $\eta^2 T \propto (T + T_0)^{-5}$). D. S.

73. Action of magnetic and electric fields on flow of *p*-azoxyanisole. G. Mikhailov and V. Zvetkov. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 5, *pp.* 597–601, 1939. *In Russian.*—The paper continues previous work on the action of magnetic and electric fields on viscosity in the nematic phase [see Abstract 4490 (1939)]. It is shown that the effect of a magnetic field normal to the flow direction reaches saturation for a field depending on the velocity. The viscosity of *p*-azoxyanisole when its molecules are oriented parallel to the flow but normal to the velocity gradient is found to be about 4 times the viscosity when molecules are normal to the flow but parallel to the velocity gradient. From the simultaneous action of magnetic and electric fields it is confirmed that the effect of an electric field is due to the orienting effect of the flow set up by the electric field. D. S.

74. Flow of anisotropic liquids in rotating magnetic fields. V. Zvetkov. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 5, *pp.* 602–615, 1939. *In Russian.*—It is found that anisotropic liquid azoxyanisole is set into rotation by a rotating magnetic field (of several thousand gauss) and hence produces a couple on its containing vessel. This couple depends on the field strength, the speed of rotation and the temperature. This effect is interpreted as due to the small rotational mobility of the structural units of the liquid crystal, and the size of these units is estimated from the experimental data as $\sim 10^{-3}$ to 10^{-2} cm. D. S.

75. Relationships between viscosities and elasticities of amorphous substances. A. Smekal. *Zeits. f. phys. Chem.*, **44**, *Abt.B.* 4, *pp.* 286–298, 1939.—In addition to the Kuhn extension [see Abstract 1022 (1939)] of the Maxwell treatment of the relationship between the viscous and elastic properties of liquids, the following results are now submitted: (*a*) The elastic-viscous molecular cohesion mechanisms of liquids are in general neither stable nor independent of each other. The normal mobile liquid region appears to be characterised only in concentration properties by stable cohesion mechanism. Undercooled melts show, however, at least in the under-cooled region, a transformation of the cohesion mechanism which may depend on the repression of crystallization power. The adjacent temperature range of 50° to 100° to such undercooled melts contains stable cohesion mechanism which is connected with the vitreous state. (*b*) It is shown from measurements of six different silicate glass melts that the Maxwell relation between viscosity, elasticity and time of relaxation in the highly viscous state is satisfied dimensionally, and therefore may be used for the estimation of freezing viscosities. (*c*) The quantitative requirement of the Maxwell relationship is inhibited by the presence of further relaxation times. The freezing procedure is in general bound up with a multiple of cohesion mechanisms and related times of relaxation. (*d*) It is shown from an example of the elastic after-effect in the solid glass state that the introduction of several alterations of cohesion mechanism does not afford a satisfactory explanation of the facts, because of the peculiar changes in the solid glass with time. H. H. Ho.

ASTRONOMY AND ASTROPHYSICS.

ASTRONOMICAL APPARATUS AND OBSERVATORY EQUIPMENT.

***76. Harvard Observatory telescope drive.** H. E. Hanson. *Roy. Astron. Soc. Canada, J.*, **33**, *pp.* 329–332, *Oct.*, 1939.—The author classifies electric drives into types of synchronous motors connected to (1) a constant-frequency power supply, (2) a frequency-controlled power supply, also (3) the Gerrish drive or pendulum-controlled mechanism. This last has serious objection in the many contacts and relays used. A schematic drawing is made of this, and its operation is described. The Harvard new telescopic drive has the advantages of the Gerrish without its complicated electrical circuit. A sketch of it is given and also a description of its operation. A. S. D. M.

See also Abstracts 158, 159.

DYNAMICAL PROBLEMS (ASTRONOMICAL).

See Abstracts 89, 90.

NEBULAE.

77. Physical processes in gaseous nebulae. Part VIII. U.v. radiation field and electron temperature of an optically thick nebula. L. H. Aller, J. G. Baker and D. H. Menzel. *Astrophys. J.*, **90,** *pp.* 601–610, *Nov.*, 1939.—The theory of the transfer of radiation in the Lyman continuum [(see Abstract 3939 (1939)] is applied to a numerical example. A central star radiating as a black body at a temperature of 80 000° C. is assumed to illuminate a nebular shell whose optical thickness at the Lyman series limit is 3·0. The numerical methods of solution are discussed in detail. The redistribution of electron velocities by collisions and free-free transitions is shown to have considerable effect upon the character of the radiation field. Near the series limit more radiation gets through the nebula than would otherwise be expected. The electron temperature at the inner boundary is almost that of an optically-thin nebular shell, and at the outer boundary it approaches that of the central star. Authors.

PLANETS.

78. Distribution of perihelia and nodes of small planets. Causes of variations in monthly number of their discoveries. B. de Jekhowsky. *Comptes Rendus*, **209,** *pp.* 505–507, *Sept.* 25, 1939.—Basing his work on the study of 1417 asteroids taken in groups of 200 each and considering the influence of Jupiter and Saturn the author gives for percentage in each quadrant values which are better than those of P. Stroobant [*Ann. Obs. R. Belgique*, **9,** 3 (1907)]. He considers that there is always an accumulation of the nodes in the two first quadrants and that the regions poorest in ascending nodes of asteroids correspond to positions of the nodes of Jupiter and Saturn. It is found that the number of asteroids varies not only from one month to another but also from one year to another. The conclusion is that the number of the discoveries of asteroids is greater in the neighbourhood of the equinoxes, being given that at these epochs the observations bear upon the regions of the sky where an accumulation of asteroids exists, notably in the proximity of one of the two principal planets. The number of the discoveries is always greater during the years in which the influence of one of the two planets is added to that of the other. J. J. S.

STARS.

79. Brightness of star 9r of north-polar sequence. G. Hartwig. *Zeits. f. Astrophysik*, **18**, 4–5, *pp.* 362–364, 1939.—The photographic and photovisual brightnesses of the star 9r of the north-polar sequence are determined in the international system as $11^{\text{m}}.94$ and $10^{\text{m}}.87$ respectively.

J. E. K.

80. Proper motions and mean absolute magnitudes of class N stars. R. E. Wilson. *Mt. Wilson Observat. Contrib. No.* 615, *Astrophys. J.*, **90**, *pp.* 352–367, *Oct.*, 1939.—The investigation is based upon the proper motions of 106 stars and upon the radial velocities of 145 stars. The mean parallax of the proper-motion stars obtained from the parallactic and peculiar motions is $\bar{\pi} = 0{\cdot}''00166 \pm 16$. The mean absolute magnitude computed from this parallax agrees well with that derived by Sanford from the galactic rotation factor. The data are satisfactorily represented by Plaskett's value of the rotational constant, $A = 15{\cdot}5$ km./sec. kpc., and by an effective galactic absorption of visual light, $a = 0{\cdot}2$ mag./kpc. The mean absolute magnitude of the stars is found to be $\overline{M} = -1{\cdot}84 \pm 0{\cdot}20$. When the data are divided into groups according to spectral subtypes and character of light-variation, there appears to be comparatively little deviation in $\overline{M}$ from that given by all the data, except in the case of the emission stars, which appear to be about $2{\cdot}5$ mag. brighter than the stars in the other groups. Author.

81. Mean absolute magnitude of class-R stars. R. E. Wilson. *Mt. Wilson Observat. Contrib. No.* 618, *Astrophys. J.*, **90**, *pp.* 486–493, *Nov.*, 1939.—Comparisons of the parallactic and peculiar motions derived from the proper motions of 28 and the radial velocities of 37 class-R stars indicate for the proper-motion stars a mean parallax, $\bar{\pi} = 0''{\cdot}00180 \pm 18$. The mean absolute magnitude of these stars, uncorrected for dispersion, is $M_\pi = -0{\cdot}22 \pm 0{\cdot}22$. The mean absolute magnitude of the radial-velocity stars, as derived from the galactic-rotation factor, and also uncorrected for dispersion, is $M_r = -0{\cdot}79 \pm 0{\cdot}94$. If the distribution in $\log \pi$ is Gaussian, these results may be brought together with the dispersion $\sigma_{\log \pi} = \pm 0{\cdot}222$. The concluded mean value for the stars of class R is $M = -0{\cdot}50 \pm 0{\cdot}20$. There appears to be no evidence of a difference in M between the stars of subclasses R0–R4 and R5–R9. Author.

82. Cyanogen discriminant between giant and dwarf stars. D. Hoffleit. *Astrophys. J.*, **90**, *pp.* 621–624, *Nov.*, 1939.—The CN band, used by F. Becker as a criterion for discrimination between giant and dwarf stars, has been examined on Harvard small-dispersion (400 Q per mm.) spectra for 128 stars of spectral classes G and K. Comparisons of the *g* and *d* classifications thus obtained with those determined by Becker and with Payne-Gaposchkin's classifications based on colour excesses, indicate that the CN criterion affords a safe discriminant between normal giant and dwarf stars but that it is subject to large uncertainties in supergiants.

Author.

83. Red indices in southern selected areas. C. Payne-Gaposchkin. *Astrophys. J.*, **90**, *pp.* 321–351, *Oct.*, 1939.—The red indices of nearly 5 000 stars, in the Selected Areas at −60°, for which spectral classifications have been made at Potsdam, furnish material for a discussion of spectrum and colour in relation to galactic structure. The Potsdam system of spectral classification differs appreciably from the Henry Draper system. The accidental errors of both systems have been evaluated as functions of spectral class and apparent magnitude. The Harvard system does not contain as many subdivisions as the accidental error of classification warrants; the Potsdam system, on the other hand, is too finely subdivided. The systematic differences of classification are functions both of apparent and of absolute magnitude. Of the 12 Selected Areas studied, 6 are in galactic latitude greater than 20° where obscuration should, on the average, be negligible. For these 6 areas, containing 400 stars, the colours are normal throughout the spectral sequence. The high-latitude areas can therefore be used as standards of normal colour for comparison with other areas. The 6 low-latitude areas differ in spectral make-up and in degree of obscuration. Selected Area 193 (Carina) shows extremely little reddening, and the frequency of blue stars is the greatest in this area: the negative density gradients that have been derived for blue stars in this part of the sky are partly a result of systematic errors of spectral classification. The other 5 areas, while differing in spectral make-up, show similar colour excesses, not very different from those found by other investigators in other parts of the sky. The principal results of the analysis is the stress that it lays on the importance of standardizing both spectral classification and magnitude systems. Otherwise, accurate and consistent conclusions on galactic structure cannot be drawn from studies of colours and spectra of faint stars. AUTHOR.

84. New identifications of Fe III in spectra of early B stars. P. SWINGS, B. EDLÉN AND J. GRANDJEAN. *Astrophys. J.*, **90,** *pp.* 378–386, *Oct.*, 1939.—Starting from their laboratory measurements, the authors are able to show that about 100 lines observed in the spectra of early B-type stars are due to Fe III. The ionization potential of Fe III is 30·48 V. [See Abstract 171 (1939).] AUTHORS.

85. Spectra of M supergiant stars. L. SPITZER, JR. *Mt. Wilson Observat. Contrib. No.* 619, *Astrophys. J.*, **90,** *pp.* 494–540, *Nov.*, 1939.—The stars α Orionis and α Herculis are examined in region $\lambda\lambda$ 4 000–4 300, for 5 multiplets of neutral Fe and 1 of Mn. The atomic absorption coefficient (α_λ) increases to some 500 times its classical value as given by the usual radiation damping value, and this is attributed to a turbulent distribution of velocities. The α Orionis atmosphere temperature varies from 2 100° (excitation) to 17 000° for the $L\alpha$ radiation energy density and up to 200 000° for that from the observed velocities magnitude. α Orion, α Scorp. and α Herc. show asymmetries in the strong ultimate lines, and this asymmetry is attributed to a thin shell of outward moving atoms, (whose velocities range from 4 to 40 km./sec.), absorbing radiation from the violet side of the normal symmetrical lines. It is suggested that an ionization cycle is set up operating only under conditions of the number of free electrons and restriction of the ionizing radiation intensity. A. S. D. M.

86. Negative ions of hydrogen and opacity of stellar atmospheres. R. WILDT. *Astrophys. J.*, **90,** *pp.* 611–620, *Nov.*, 1939.—Compared with the current theory of the atmospheric absorption coefficient, the photospheric level is raised considerably in all spectral types later than F5 by including the contribution to the opacity made by the negative ions of hydrogen. Likewise, the discontinuity at the Balmer limit is greatly reduced, so the values of this quantity observed in F stars can be represented without the assumption, advocated by Unsöld, of an abundance ratio of hydrogen to metals equal to 50 : 1. The abundance ratio adopted by Russell and Pannekoek ($H : M = 1\,000 : 1$) appears to be compatible with the observations of the Balmer discontinuity. AUTHOR.

87. U.v. spectra of A and B stars. O. Struve. *Astrophys. J.*, **90,** *pp.* 699–726, *Dec.*, 1939.—This paper contains (*a*) the measured wavelengths of 350 absorption lines in the A stars α Cygni, α Lyrae, η Leonis, and α^1 Canum Venaticorum, between λ 3 227 and λ 3 957; (*b*) the measured wavelengths of 198 lines in the O and B stars 10 Lacertae, τ Scorpii, β Cephei, γ Pegasi, and 55 Cygni. The identifications of the star lines with laboratory lines are given for each group of stars. Author.

88. U.v. spectra of 17 Leporis and P Cygni. O. Struve and F. E. Roach. *Astrophys. J.*, **90,** *pp.* 727–753, *Dec.*, 1939.—The u.v. spectrum of 17 Leporis is compared with that of α Cygni. Ti II, Sc II, and Mn II are greatly enhanced in 17 Leporis. Si II is abnormally weak. From the relative intensities of three Mg I lines it is found that the dilution factor $W > 10^{-4}$. Other estimates suggest $0{\cdot}1 > W > 0{\cdot}01$. The observations are, in general, consistent with the theory of cycles. 115 lines were measured in the spectrum of P Cygni between λ 3 265 and λ 4 026. The Balmer series is followed to $n = 23$. The triplet diffuse series of He I is found to extend to appreciably higher members than the singlet diffuse series. The 2^3P level is estimated to be overpopulated by a factor of 3. This could be caused by a dilution factor $W = 0{\cdot}05$, which corresponds to $R/r = 0{\cdot}4$, where R and r are the radii of the star and of the shell, respectively. The Si III triplet, $4p^3P^0 - 4d^3D$, is found to be in emission in contrast with the well-known triplet $4s^3S - 4p^3P^0$, which is in absorption. Several strong lines are due to Fe III. The effect of dilution in this spectrum is discussed. Authors.

89. Stability of spheres of simple mechanical fluid held together by Newtonian gravitation. R. C. Tolman. *Astrophys. J.*, **90,** *pp.* 541–567, *Nov.*, 1939.—A sphere of simple mechanical fluid held together by Newtonian forces of gravitation will be in stable equilibrium if its total potential energy is a minimum. Using the principles of the calculus of variations, it is shown that any equilibrium distribution of fluid would, in general, automatically satisfy all tests for a minimum except that of Jacobi as to the location of conjugate points. The circumstances which lead to failure of the Jacobi test and the consequences which arise from such failure are discussed and illustrated. [See following Abstract.] Author.

90. Stability of stellar models and origin of novae. R. C. Tolman. *Astrophys. J.*, **90,** *pp.* 568–600, *Nov.*, 1939.—A brief review is first given of the results previously obtained by various investigators concerning the secular stability of stars, the stability of pulsating stars, and the relative stability of the processes of radiative and of convective thermal transfer in the interior of stars. The present article then considers, as a further aspect of the general problem, the stability of stars toward infinitesimal, instantaneous fluctuations in the distribution of stellar fluid. The necessary and sufficient criterion for such stability is that the available potential energy of the stellar model shall be a minimum toward reversible, adiabatic variations in the distribution of fluid. Setting up the integral which expresses the available potential energy, and applying the calculus of variations, it is found that this integral in general automatically satisfies all tests for a minimum, except that of Jacobi as to the location of conjugate points, where special investigation must be made in each separate case. Carrying out such investigations of the Jacobi test as are readily feasible, it is found that there is no reason to expect instability of the kind under consideration in the case of simple stellar models having radiative (or convective) thermal transfer throughout. It is also found, however, that the presence of a central convective zone or of a convective zone just under the surface of a star, otherwise having radiative thermal transfer, can introduce factors tending toward failure of the Jacobi test. Further investigation would be necessary to determine whether instability arising in such a manner could actually play an important rôle in stellar behaviour. The article closes with remarks as to various explanations for stellar novae which have been proposed, including the tentative new suggestion that their origin might be due to instability arising from failure of the integral of available potential energy to satisfy the Jacobi test for a minimum. [See preceding Abstract.] AUTHOR.

91. Dissipation of planetary filaments. L. SPITZER, JR. *Astrophys. J.*, **90,** *pp.* 675–688, *Dec.*, 1939.—An investigation is made of the forces acting on a cylindrical filament of stellar matter produced by an encounter between two stars. It is shown that under rather general assumptions such a filament will expand under its own internal pressure much more rapidly than it will lose energy either by radiation or by turbulent convection. A similar conclusion may be deduced for a thin ribbon-like filament produced by a grazing collision. It seems probable that a stellar encounter will simply produce an extended gaseous nebula around one or more of the stars involved. AUTHOR.

92. Fundamental physical processes of the nova phenomenon. L. BIERMANN. *Zeits. f. Astrophysik,* **18,** 4-5, *pp.* 344–361, 1939.—According to the author's conception of the nature of the eruption of novæ the potential novæ are, in the stationary state, stars of early spectral type but mean absolute brightness which flash up at irregular intervals of the order of 100 to 10 000 years and then return practically to their original states. Since these stars have almost completely lost their H through nuclear processes they rely on contraction as a source of energy and in a time of the order 10^7 to 10^8 years they pass over into the white-dwarf state. It is shown that in stars of such chemical constitution the zones with temperature $\leqq 0 \cdot 1\ T_{\text{centre}}$ are on the brink of thermal instability and that conditions are favourable to the building up of instability from time to time followed by very sudden collapse. The theory explains the amount of energy radiated during an outbreak, the observed frequency of eruption of novæ and the observed velocities of expansion. J. E. K.

93. Magnitudes and colours in the globular cluster Messier 4. J. L. GREENSTEIN. *Astrophys. J.*, **90,** *pp.* 387–413, *Oct.*, 1939.—Magnitude sequences have been established in the giant-poor globular cluster, M 4, in both the photographic- and the red-magnitude systems. Each sequence involves two completely independent determinations. The magnitudes and colours of 660 stars in the clutser, to absolute magnitude (red) $+ 1 \cdot 4$, have been measured and are given in a table. The cluster is found to be reddened by $+ 0 \cdot 8$ mag. by the dark nebulosity in Scorpio-Ophiuchus. After correction for absorption the distance of the cluster is 1 900 parsecs, the closest to the sun of the globular clusters. The colour-magnitude array for the cluster stars is similar to those found by Shapley. There is a peculiar group of blue stars near absolute-magnitude zero, distinguishing the cluster from galactic clusters and from field stars in the galaxy. Subgiants are very abundant, but bright main-sequence stars are completely absent. The cluster-type variables are similar to those in the galactic field ; two longer-period variables are found to be very red. The frequency function of the magnitudes is analyzed, and various statistical properties are derived. The space distribution of fainter cluster stars is investigated by means of star counts. The expected velocity dispersion is found to be near 11 km./sec. AUTHOR.

94. Proper motions in galactic cluster NGC 2548. E. G. EBBIGHAUSEN. *Astrophys. J.*, **90,** *pp.* 689–698, *Dec.*, 1939.—Proper motions are derived on Yerkes plates for an area $30'$ in dia. centred on the cluster NGC 2548. Plots of the motions are given. The positions of the probable cluster members are found. The spectrum-magnitude diagram of the cluster and the luminosity function of the cluster are figured.
AUTHOR.

95. Ellipticity in eclipsing binaries. H. N. RUSSELL. *Astrophys. J.*, **90,** *pp.* 641–674, *Dec.*, 1939.—The constant K, derived from Cowling's formula for apsidal motion in a close binary, is computed for 19 systems. Many of the values are rough, but all are small. The largest value found from reliable data is $0\cdot018$—very much nearer to a Roche model ($0\cdot000$) than to a homogeneous one ($0\cdot750$). Refinements of calculation would diminish the calculated values. The values of K certainly differ from star to star. The " photometric ellipticity " derived from the variation outside eclipse depends on the darkening at the limb and the variation of surface brightness with gravity, as well as on the geometrical form. The gravity effect approximately doubles the observed variation. The gravity effect can be well studied by this means ; the geometrical shape and internal constitution cannot be found in this way. The light-curve resulting from an eclipse of two prolate, uniformly bright, ellipsoidal stars of different shapes can be very closely represented by the eclipse of two stars of the same shape but of different dimensions. The outstanding residuals simulate the effect of a small degree of darkening at the limb. It is impracticable to find the difference in shape from the light-curve. It is recommended that the ellipticity of figure calculated on dynamical principles from the Roche model (or perhaps with $K = 0\cdot01$) should be used in determining the geometrical elements of eclipsing variables. AUTHOR.

See also Abstracts 162, 163, 164.

SUN.

96. Intensity changes in bright chromospheric disturbances. R. S. RICHARDSON. *Mt. Wilson Observat. Contrib. No.* **616,** *Astrophys. J.*, **90,** *pp.* 368–377, *Oct.*, 1939.—Intensities are given for 18 bright chromospheric disturbances observed at Mt. Wilson for which complete photographic records are available. The values are a combination of the measured areas of the flocculi and eye-estimates of their individual brightness. On the assumption that the chromospheric emission in Lyman α is five times stronger than in Hα, radiation through the atmospheric " window " from $\lambda\lambda$ 1 100–1 300 during a bright chromospheric disturbance of intensity 2 or 3 should be about 60% greater than normal. AUTHOR.

97. Sunspot spectra. Parts I and II. P. TEN BRUGGENCATE AND H. V. KLÜBER. *Zeits. f. Astrophysik*, **18,** 4-5, *pp.* 284–315, *and pp.* 330–343, 1939. —The first half of Part I of this paper is devoted to a historical survey of investigations of sunspot spectra followed by particulars of the apparatus used in the present investigation, the observational procedure, the results and the accuracy of measurement. The second half deals with the derivation of sunspot temperatures and other data from the observations. The growth curve of a sunspot is determined on the basis of Ti and Fe lines ; from the multiplet displacements in the growth curve diagram excitation temperatures $T = 5\,040^\circ$ and $T^* = 3\,800^\circ$ are derived for photosphere and spot respectively. Comparison of growth curves for spot and centre permits estimation of the ratio of the number of neutral Ti and Fe atoms in the ground state in the spot to the corresponding numbers referred to the photosphere. Part II concerns photometry of two Mg lines λλ 5 183 and 5 172 Å of the (3^3P-4^3S) triplet. The total absorption of λ 5 183 is $E = 1 \cdot 77$ Å in photosphere and $E^* = 2 \cdot 50$ Å in sunspot; the effective number of atoms is twice as great in the spot as in the photosphere. Residual intensities of λ 5 183 and λ 5 172 in photosphere and spot amount to approximately 8%. It is shown that for energies corresponding to the ionization potential of Mg, 7·6 volts, there are noteworthy deviations from normal equilibrium such as to give higher ionization both in photosphere and spot. 52 faint lines in the wings of λλ 5 183 and 5 172 are identified with lines of the green Mg H band. J. E. K.

GEOPHYSICS.

HYDROSPHERE, PHYSICS OF THE

98. Radioactivity of Saratoga Spring waters and rocks. O. BAUDISCH AND A. K. BREWER. *Am. J. Sci.*, **237,** *pp.* 811–817, *Nov.*, 1939.—In 1914 R. B. Moore and C. F. Whittemore tested the various waters and deposits at Saratoga Springs for radioactivity. The conventional emanation electroscope was used. Radon but no thoron was found in the waters and gases. The waters and deposits were also observed to contain radioactive salts. Due to excessive pumping, the water level at the time their measurements were made was very low compared with the present day. Saratoga Spring waters have now been re-examined for radioactivity. The method employed is entirely different from that used by Moore and Whittemore. In the present experiments the β-ray emission is measured by means of a special β-ray counter. The only radioactive elements detected in the deposits or dissolved salts are Ra and K. The K is the same as ordinary K to within 10%. The concentration of dissolved Ra is very nearly the same as that observed by Moore and Whittemore. This indicates that time and the hydrostatic level of the waters have produced only minor changes in the radioactivity. AUTHORS.

LAND, PHYSICS OF THE

99. Cost of soil in rock and time. W. H. TWENHOFEL. *Am. J. Sci.*, **237,** *pp.* 771–780, *Nov.*, 1939.—The article considers the geological cost of soils in terms of the destruction of quantity of rock and duration of time required for production. It is emphasized that the more resistant rocks require inmense periods of time to disintegrate and decompose into soil materials and, correspondingly. equally immense periods of time exist for removal of the products of destruction and, hence, there may be very limited and even no accumulation of residual materials at the places where the rocks are destroyed. Very resistant rocks, as quartzite, may lose the detached particles about as rapidly as release from the parent rocks takes place. Soluble rocks, as the limestones, lose immense quantities of the insoluble residues as the soluble parts are removed in solution and thus immense thicknesses of these rocks may be required to produce a very small thickness of residual accumulation. Poorly resistant rocks, as clays, shales, and poorly cemented sandstones, repair the ravages of erosion fairly quickly and, hence, soils derived from such rocks require small thicknesses of rock and short periods of time for production. Soils, hence, have very different geological values. This fact should be appreciated by all those on whom the responsibility of soil preservation rests. AUTHOR.

See also Abstract 98.

METEOROLOGY.

100. Periodicities in measures of solar constant. T. E. STERNE. *Nat. Acad. Sci., Proc.*, **25,** *pp.* 559–564, *Nov.*, 1939.—540 ten-day mean values of the solar constant, published by Abbot in *Smithsonian Miscellaneous Collections*, **94,** *No.* 10, *p.* 12 (1935), have been examined by least squares. The coefficients, and their mean errors, have been determined of the sine and cosine terms corresponding to each of 10 periods, lying between 7 and 68 months, that have been suggested by Abbot. It is found that 7 periods (9·75, 11, 21, 25, 39½, 46 and 68 months) are of strongly suggested statistical significance and must in all probability be present either in the systematic errors of the 10-day means, in the solar radiation, or in both. Three periods can reasonably be attributed to statistical fluctuations. An annual periodicity not suggested by Abbot is found ; it is of strongly suggested statistical significance, and it is thought likely that it occurs in the systematic errors. [See Abstract 2447 (1939).] AUTHOR.

101. General circulation of the atmosphere over India and its neighbourhood. K. R. RAMANATHAN AND K. P. RAMAKRISHNAN. *India Meteorolog. Dept., Mem.*, **26,** 10, *pp.* 189–245, 1939.—The paper gives charts of mean air movement in each month over the Indian region at different heights up to 8 km. derived from observations of pilot balloons at the observatories of the India Meteorological Department. As complementary to the charts of pilot balloon winds, which refer mainly to days of clear weather, charts of movement of low, medium and high clouds are also given for five months. Upper air temperatures deduced from the change of wind with height are also shown on the charts. The charts for the lower levels contain as insets wind-roses for selected stations. The chief features of the upper wind and temperature distribution in each month are described and their relation to the major climatological features such as monsoons and storms are pointed out. Some of the points discussed are :—(i) the boundaries between easterly and westerly winds in different months of the year. (ii) the influence of the Himalayas and adjacent mountain ranges on the circulation, (iii) the increase of temperature in the upper levels over regions of heavy rainfall, and (iv) the greater northward movement of air in cloudy weather than in clear weather. Tables of resultant and predominant winds as well as frequencies of directions of cloud movement are appended. AUTHORS.

102. Polarization of diffused light, radiation of the atmosphere and probable weather indications. E. MEDI. *Ricerca Scientifica*, **10,** *pp.* 790–797, *Sept.*, 1939.—Simultaneous observations were made of the course of the state of polarization of the light diffused from a region of the atmosphere and that of the energy radiated from the same region. From the results obtained in this comparative study there are indications that in many cases it may be possible to decide how far the atmosphere will remain in its actual condition, or undergo changes. For the study of the polarization a new method was devised and applied which is specially adapted to this kind of research. J. J. S.

103. Atmospheric sodium. S. Chapman. *Astrophys. J.*, **90,** *pp.* 309–315, *Sept.*, 1939.—It is suggested that Na atoms in the high atmosphere may have a long, though intermittent, free life, despite frequent combination with O atoms to form NaO, through the reaction $NaO + O = Na + O_2$. The source of energy of the light emitted by Na at night is ascribed to the dissociation energy of O_2. The level of emission of this light is also discussed. Author.

SEISMOLOGY.

104. New type of wave of longitudinal character between the phases P and S. E. Rosini. *Ricerca Scientifica*, **10,** *pp.* 798–808, *Sept.*, 1939.—Even in the interval of the epicentral distances in which the seismograms have the most simple interpretation there is frequently observed the presence of trains of waves not yet defined. The present paper treats of the individualization of a type of wave situated between the P and the S that seems to present some well defined characteristics peculiar to itself. The research so far is entirely of an observational nature and includes the construction of a provisional dromochrome of the new wave. In the present description of its chief characteristics this wave has perfect longitudinality, and period relatively long increasing with the distance. J. J. S.

TERRESTRIAL ELECTRICITY AND MAGNETISM.

105. Intermediate ions of the atmosphere. A. R. Hogg. *Phys. Soc., Proc.*, **51,** *pp.* 1014–1027, *Nov.*, 1939.—Evidence is produced to show that (*a*) the smaller nucleated ions in city air exist in separate groups with distinct mobilities; (*b*) the variation of the mobility of these ions with humidity is such as to lead to the conclusion that the ions are composed of droplets of sulphuric acid; (*c*) it appears that the ions result from the aggregation of particles containing about 2 200 molecules of sulphuric acid or multiples thereof. The acid, before and after aggregation, is hydrated to an extent dependent on the temperature and the humidity of the atmosphere and on the radius of the droplet. Author.

106. Ball lightning. H. T. Flint. *Roy. Meteorolog. Soc., J.*, **65,** *pp.* 532–535, *Oct.*, 1939.—Neugebauer suggests [see Abstract 4446 (1937)] that the presence of charges of both signs gives ground for supposing that in the case of a ball in which positive charges are embedded amongst a collection of negative charges, the energy arising from mutual action and from polarization is small and that the contribution from the source revealed by the quantum theory is the dominating factor. The stability is examined by means of the expression for the energy of the ball but reliance must be placed on the quantum theory of the electron gas. The energy thus introduced arises automatically as a result of the application of the principles of the quantum theory. The formula for the energy enables an explanation to be given whether ball lightning ends in the ball contracting and finally disappearing silently or else with a loud report. The duration of the ball is explained by the slow rate of recombination of unlike charges under the conditions prevailing within it. R. S. R.

107. Statistical study of 11-year cycle of semidiurnal component of magnetic declination. (MME.) AND H. LABROUSTE. *Comptes Rendus*, **209**, *pp.* 689–691, *Nov.* 6, 1939.—The semidiurnal component of magnetic declination has been analyzed in the same way as for the diurnal component [see Abstract 4530 (1939)]. The mean values of the semidiurnal amplitude can be classified according to geomagnetic latitude to 50° but for higher latitudes the mean values are feebler. The magnetic curves of the 11-year semidiurnal amplitude are generally in phase with solar activity but with a retardation, notably for American stations. The 11-year phase oscillation is sensibly in agreement with that for solar activity or shows a slight retardation for most stations but not for Sodankyla or Lerwick. R. S. R.

RADIOACTIVITY.

108. Evidence for a chain nuclear reaction in the middle of a uraniferous mass. H. HALBAN, JR., F. JOLIOT, L. KOWARSKI AND F. PERRIN. *J. de Physique et le Radium*, **10**, *pp.* 428–429, *Oct.*, 1939.—A hollow Cu sphere, 50 cm. dia. containing at its centre a source of photoneutrons (Ra + Be), was immersed in water, and the density of the neutrons was measured by the activity I induced in Dy detectors placed either inside the sphere or in the surrounding water, when the sphere was filled with (i) water, (ii) dry U_3O_8, (iii) damp U_3O_8 (H/U = 1, 2, and 3). From a consideration of the curves $I^2 = f(r)$, where r is the distance from the source to the detector, it is concluded that some of the neutrons produced are of secondary and tertiary origin, indicating that convergent chain reactions occur. W. R. A.

109. Element 87, AcK, a derivative of actinium. M. PEREY. *J. de Physique et le Radium*, **10**, *pp.* 435–438, *Oct.*, 1939.—Experiments are described indicating that to the extent of 1% Ac disintegrates with evolution of α-particles to form a new radioactive element, AcK, of atomic number 87, an isotope of moldavium [see Abstract 193 (1940)]. It displays β-ray activity, and its period is 21 min. It is carried down with the perchlorate or chloroplatinate of Rb or Cs, but not with a salt of Na or K. [See Abstract 1088 (1939) and following Abstract.] C. A. S.

110. Radiation of AcK. M. PEREY AND M. LECOIN. *J. de Physique et le Radium*, **10**, *pp.* 439–440, *Oct.*, 1939.—The continuous β-ray spectrum of AcK [see preceding Abstract] was measured by means of a Wilson chamber. It differs markedly from those of AcB or AcC″. The possibility of this being attributable to radioactive impurities, e.g. AcB and AcC″, is discussed. A few positrons were also observed, which may be due to materialization of γ-rays in the material used as support, e.g. mica or Al. C. A. S.

111. Quantitative study of pleochroic haloes. Parts IV and V. G. H. HENDERSON AND F. W. SPARKS. *Roy. Soc., Proc. A*, **173**, *pp.* 238–264, *Nov.* 28, 1939.—In Part IV four types of haloes, provisionally designated as A, B, C and D, are described, three of them for the first time. These haloes have one, two, three and one rings respectively. Measurements of ring radii are given. The mode of occurrence of the haloes is described.

It is shown that they are probably due to α-particles from certain later members of the U family, whose lives are exceedingly short on a geological time scale. Six types of pleochroic haloes are discussed in Parts IV and V, divided into two classes " active " and " extinct". To the former class belong U and Th haloes, to the latter types designated tentatively A, B, C and D. To account for entinct types of haloes a hypothesis is advanced that they originate from hydrothermal solutions. Such solutions diffused through conduits or clefts in the biotite crystal and particular radioactive elements of the U family were deposited from them at certain centres of precipitation. By a continuous process there was thus incorporated in a halo nucleus a quantity of a short-lived element sufficient to produce a halo. In this way all four extinct types can be explained. In active haloes this method of halo formation also occurred but the possibility is also open that the halo nucleus was formed prior to the crystallisation of the biotite. All halo rings can be accounted for by known types of α-particles and no evidence is found for unknown elements which may once have existed in the earth and have now disappeared. [For Part III see Abstract 601 (1937).] AUTHORS.

112. Artificial radioactive indicators. C. ROSENBLUM AND J. F. FLAGG. *Frank. Inst., J.*, **228,** *pp.* 471–494, *Oct., and pp.* 623–648, *Nov.*, 1939.—A review dealing with the preparation of artificial radioactive sources suitable for indicators, and their application to the study of the course of chemical reactions, botanical and biological work. A bibliography is given. A. J. M.

113. Nuclear photo-effect in Be. M. KORSUNSKIJ, N. NIKOLAEVSKAJA AND M. BAKH. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9,** 5, *pp.* 517–523, 1939. *In Russian.*—The yield of neutrons from Be irradiated by hard radiation from an impulsively excited tube was investigated in dependence on the tube potential, V. The activity of the silver or iodine indicator was found proportional to $(V\text{-}V_0)^3$ where V_0, the lower limit of excitation, is 1 550 kV. This result is found not to agree with Bethe and Peierls's formula for the case of photodisintegration of the deuteron. D. S.

114. Possible formation of α-radioactive nuclei in decay of radioactive Cl. N. DMITRIEV, K. PETRZHAK AND N. PERFILOV. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9,** 6, *pp.* 654–657, 1939. *In Russian.*—The α-radioactivity in the decay of radiochlorine reported by Libby, Peterson and Latimer (*Phys. Rev.*, **48,** *p.* 571, 1935), and attributed by these authors to argon atoms formed from the radiochlorine, was looked for but not found. The experiments were carried out firstly with a Wynn-Williams counter, no α-particles of range greater than 2 mm. being found, and finally with a reduced pressure Wilson chamber to look for slower α-particles. D. S.

115. Degradation of the uranium nucleus. J. THIBAUD AND A. MOUSSA. *J. de Physique et le Radium*, **10,** *pp.* 388–390, *Aug.*, 1939.—In continuation of previous work [see Abstract 2016 (1939)] on the rupture of U, the authors conclude that many processes of rupture are possible. If the series of " ex-transuraniums " is correct, the allocation of 53 to " eka-platinum " shows the rupture to produce No. 49. The series proposed by Hahn and Strassman (*Naturwiss*, **26,** *p.* 451, 1939) yields a ratio of initial atoms of the two elements increasing with θ, tending to the equilibrium

$$\underset{92}{\mathrm{U}} \xrightarrow{10\text{ sec.}} \underset{93}{\text{Eka-Re}} \xrightarrow{2\cdot2\text{ min.}} \underset{94}{\text{Eka-Os}} \xrightarrow{59\text{ mins.}} \underset{95}{\text{Eka-Ir}} \xrightarrow{66\text{ hr.}} \underset{96}{\text{Eka-Pt}} \xrightarrow{2\cdot3\text{ hr.}} \underset{49}{\mathrm{In}} \rightarrow \underset{50}{\mathrm{Sn}} \rightarrow \underset{51}{\mathrm{Sb}} \rightarrow \underset{52}{\mathrm{Te}} \rightarrow \underset{53}{\mathrm{I}}.$$

Rupture thus occurs between the couple In-Ma (49-43) and possibly between Cs-Rb (55-37) and La-Br (57-35). D. R. H.

116. Internally converted γ-rays of several radioactive elements. G. E. Valley and R. L. McCreary. *Phys. Rev.*, **56,** *pp.* 863–871, *Nov.* 1, 1939.—The conversion electron spectra of a number of radioactive elements produced by proton and deuteron bombardment in the cyclotron have been investigated. The β-ray spectrograph was designed to allow rapid replacement of the source and photographic film so that successive fresh samples of short-period activities could be used for a single exposure. The results may be summarized as follows: Br^{80} ($4\cdot4$ hr.) three conversion lines observed corresponding to two γ-rays, one of $48\cdot9 \pm 0\cdot4$ ekV and a second of either $37\cdot1$ or $25\cdot3$ ekV, both arising in the isomeric transition to the 18-min. state. Br^{78} ($6\cdot3$ min., e^+) K and L_1 conversions in Se of two γ-rays of $45\cdot8 \pm 0\cdot4$ and $107\cdot7 \pm 0\cdot9$ ekV; $Cd^{107 \text{ or } 109}$ ($6\cdot4$ hr., K capture) K, L_1 and M_1 conversions of a γ-ray of $92\cdot6 \pm 0\cdot8$ ekV. In this case there is an anomalously high L_1 conversion since the K and L_1 lines have nearly equal intensity. Also a 530-ekV γ-ray, possibly annihilation radiation, although no positrons are observed. Ga^{67} (78 hr., K capture) K and L_1 conversions of a γ-ray of $92\cdot5 \pm 0\cdot8$ ekV; Ga^{70} ($18\cdot5$ min., e^- and possible K capture) K and L_1 conversions of a γ-ray of $53\cdot8 \pm 0\cdot5$ ekV and probably a second line of about 117 ekV. Authors.

117. Radioactivities produced by proton bombardment of Pd. T. Enns. *Phys. Rev.*, **56,** *pp.* 872–876, *Nov.* 1, 1939.—Proton bombardment of Pd produces the three known Ag periods of $2\cdot3$ min. (Ag^{108}), 25 min. and 8 days (Ag^{106}), and three new periods of $16\cdot3$ min (+), 73 min. (+) and 45 days (K capture). The latter are assigned tentatively to Ag^{102}, Ag^{104}, and Ag^{105}, respectively. Excitation functions for the isomeric 25-min. and 8-day periods give *p-n* thresholds of $3\cdot8$ and $3\cdot9$ eMV, respectively. The former agrees with the known positron spectrum of the short period. The higher threshold for the 8-day period indicates that this state lies above the 25-min state. This activity is accompanied by probably three γ-rays of which two of $0\cdot62$ and $1\cdot06$ eMV have been identified with a β-ray spectrograph. Since no positrons accompany this activity it must decay mainly by K-electron capture to Pd^{106} rather than to the lower isomeric state. Four γ-rays of about $0\cdot29$, $0\cdot42$, $0\cdot50$, and $0\cdot69$ eMV accompany the 45-day period. Author.

118. Disintegration of Be by electrons. G. B. Collins, B. Waldman and E. Guth. *Phys. Rev.*, **56,** *pp.* 876–880, *Nov.* 1, 1939.—The Be nucleus has been disintegrated by fast electrons whose energies exceeded the photo-electric threshold. The source of the electrons was a $1\cdot8$-MV van de Graaff generator. As was predicted by Guth, neutrons were produced, and the radioactivity which these neutrons induced in Ag was used as a measure of the rate of disintegration. The possibility that the observed disintegration was not due to the direct action of the electrons, but resulted from stray X-rays, or X-rays produced in the Be by the electrons was eliminated. The yield curve for disintegration by electrons was obtained, and fixed the threshold for this process at $1\cdot63 \pm 0\cdot05$ eMV. At $1\cdot73$ eMV the cross-section was found to be 10^{-31} cm.^{2}, in good agreement with theory. The yield curve for photodisintegration by continuous X-radiation was also obtained, and the threshold was found to be identical with that for disintegration by electrons. Authors.

119. Transmutation of F by deuterons. J. C. Bower and W. E. Burcham. *Roy. Soc., Proc. A*, **173,** *pp.* 379–391, *Dec.* 18, 1939.—The emission of protons from F under bombardment by deuterons of 0·8 × 10^6 eV energy has been studied by means of an expansion chamber. Five groups of protons of ranges 13·0, 18·8, 21·0, 24·2 and 31·0 cm. have been found, and from the energy values of these groups it is concluded that excitation levels at 0·7, 1·0, 1·35 and 1·9 × 10^6 eV above the ground state exist in the radioactive ^{20}F nucleus. From the energy of the 31 cm. group a value of 20·0063 is deduced for the mass of radioactive ^{20}F. An energy release of 7·0 × 10^6 eV is therefore to be expected in the β decay of ^{20}F to ^{20}Ne, and the disagreement between this value and the observed β-ray end-point of 5·2 × 10^6 eV has been partially reconciled by the observation that a radioactive emission of γ-rays of 2·2 × 10^6 eV energy accompanies the β emission. The origin of this γ-radiation is discussed in terms of the level system of ^{20}Ne. It is shown that the experimental results do not support the original theory of Bethe, Hoyle and Peierls concerning the complexity of the β-ray spectrum of ^{20}F. A new transmutation of the carbon isotope ^{13}C by deuterons has been detected. Authors.

120. Transmutation of Na by deuterons. E. B. M. Murrell and C. L. Smith. *Roy. Soc., Proc. A*, **173,** *pp.* 410–417, *Dec.* 18, 1939.—The transmutations of Na under bombardment with deuterons of energy 0·85 × 10^6 eV have been investigated in detail. The two groups of α-particles which are emitted, with ranges 5·0 ± 0·1 and 3·4 ± 0·1 cm., are attributed to the process $^{23}\text{Na} + {}^{2}\text{H} \rightarrow {}^{21}\text{Ne} + {}^{4}\text{He}$. The energy of the longer range group leads to a value for the mass of ^{23}Na of 22·9961 ± 0·0003 and the shorter range group indicates the presence of an excitation level in the ^{21}Ne nucleus which is calculated to be 1·6 × 10^6 eV above the ground state. Four groups of protons are also found to be emitted with ranges of 7·5, 24·0, 33·4 and 37·8 cm. From the energy of the group of longest range a value of 23·9976 ± 0·0003 is deduced for the mass of the ^{24}Na atom. From the energy values of the other groups it is concluded that excitation levels at 0·38, 1·26 and 3·38 × 10^6 eV above the ground state exist in the ^{24}Na nucleus. The value 23·9913 ± 0·0003 is also deduced for the mass of ^{24}Mg. Authors.

121. Determination of upper limits of β-ray spectra by an absorption method. N. Godzinskij, I. Golotzvan and A. Danilenko. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9,** 5, *pp.* 513–516, 1939. *In Russian.*—An absorption method for the determination of the upper limit of the energy spectrum of weak β-ray sources is described. The end of the absorption curve is obtained by means of a modification of an extrapolation formula used by Widdowson and Champion [see Abstract 1128 (1938)]. The method gave results for UX_2 and radioactive Ag (period 22 sec.) in good agreement with those of previous authors. D. S.

122. β-ray spectrum of radio-iodine. M. Korsunskij, N. Nikolaevskaja and M. Bakh. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9,** 5, *pp.* 524–525, 1939. *In Russian.*—The energy spectrum of the β-rays from radio-iodine (I^{128}) was measured with a magnetic spectrometer using coincidence counters in the range from 0·6 to 2·0 eMV. The form of the spectrum agreed well with the Uhlenbeck-Konopinski formula. It is suggested that the slight deviations from the curve of points at 1·1 and 1·6 eMV may be due to internally converted γ-rays. D. S.

123. β-spectra of iodine. G. F. Tape. *Phys. Rev.*, **56,** *pp.* 965–971, *Nov.* 15, 1939.—Artificial activation of Te and I by deutrons and neutrons yields four radioactive isotopes of I. The momentum distributions of the β-particles emitted by these isotopes were examined in a large H_2-filled cloud chamber placed in a uniform magnetic field. Applications of the Fermi theory of β-decay and of the Konopinski-Uhlenbeck modification were made and the extrapolated end points were compared to the inspection end points. γ-radiation was found with each activity. An estimate of energies of the γ-radiation associated with I^{130} and I^{131} was determined from the electrons ejected from a lead absorber placed in the cloud chamber. The following results were obtained:

Half-life	Probable Isotope	β-Ray Energy	γ-Ray Energy
25 ±1 min.	I^{128}	2·40±0·07 eMV	(Yes)
13·0±0·3 days	I^{126}	1·20±0·03	(Yes)
8·2±0·3 days	I^{131}	0·687±0·010	0·27 eMV
12·5±0·5 hr.	I^{130}	0·83±0·03	0·46 0·59

The original Fermi theory is in better agreement with the experimental data, the Kurie plots being linear over a considerable range to the end-point. AUTHOR.

124. β-radiations of UX_1 and UX_2. J. S. MARSHALL. *Roy. Soc., Proc. A*, **173**, *pp.* 391–410, *Dec.* 18, 1939.—The distribution with momentum of the β-rays of UX has been investigated, first using a cloud chamber with particular regard to momentum values below $H\rho$ 2 000 (280 ekV), and then using a magnetic spectrometer to determine the distribution above that value. Evidence has been obtained that the β-rays of UX_1 extend at least to $H\rho$ 1 950 (265 ekV). This value taken as an end-point gives a point on the Sargent diagram well to the right of the curve of allowed transitions. This fact suggests interpretation in terms of partial spectra, an interpretation to which the shape of the cloud chamber distribution is amenable. Fermi distributions with end-points at 130 and 300 ekV ($H\rho$ 1 300 and 2 100) and areas in the ratio 4 to 5 have been fitted. The spectrometer measurements have revealed a β-ray line at $H\rho$ 3 600 (686 ekV), intensity 0·0036 ± 0·0004 per disintegration, indicating the presence of a γ-ray of energy 802ekV. From unpublished measurements by J. A. Gray, the intensity of this γ-ray has been taken tentatively as 0·05 quantum per disintegration. With this supporting evidence, the continuous distribution for the UX_2 β-rays is interpreted, above $H\rho$ 3 000 (525 ekV), as formed by two partial spectra of the Fermi type, one containing about 95% of the intensity and extending to $H\rho$ 9 300 (2·32 eMV) (this value being taken from Ward and Gray 1937), and the other with about 5% of the total intensity, extending to $H\rho$ 6 550 (1·52 eMV). The γ-ray intensity and the strength of the β-ray line give an internal conversion coefficient for the γ-ray of about 0·07. The energy of the γ-ray agrees sufficiently well with the energy of one of the γ-rays of UZ, according to Feather and Bretscher [see Abstract 1949 (1938)]. This constitutes added evidence for the isomerism of the nuclei UX_2 and UZ. AUTHOR.

125. Formulae and theoretical curves for γ-rays. T. KAHAN. *J. de Physique et le Radium*, **10**, *pp.* 430–434, *Oct.*, 1939.—Theoretical. The limits of the validity and application of the different theoretical expressions for the three photonic effects, photo-electric absorption, Compton diffusion, and materialization processes, have been considered. Various curves are given from which the number of electrons projected by the Compton effect can be determined, and which present the three effects as functions of the atomic number and of the energy of the incident quantum. W. R. A.

126. Internal absorption of γ-rays in Ra-Be neutron sources. L. F. CURTISS. *Bureau of Standards, J. of Research,* **23,** *pp.* 617–619, *Nov.,* 1939.—When neutron sources composed of Be powder mixed with a Ra salt are prepared commercially, it is sometimes desirable to determine the actual amount of Ra in such a source by γ-ray comparisons with a Ra standard. To do this it is necessary to know the amount of absorption of γ-rays within the source and its container. To compute this correction, a knowledge of the absorption coefficient of the Be powder is required, and the equations involved are difficult to work with in the case of a cylindrical source such as is commonly used. Therefore, this internal absorption has been determined experimentally for a source contained in a brass cylinder of 8-mm. internal dia. and 24·5-mm. internal length with wall 1 mm. thick. This cylinder contained a mixture of 1 237 mg. of finely powdered Be and Ra sulphate containing 139·7 mg of Ra element. From measurements made in the usual way with a γ-ray electroscope with 1 cm. of lead filtering, the absorption correction was found to be 5.1%. AUTHOR.

***127. The Purdue cyclotron.** W. J. HENDERSON, L. D. P. KING, J. R. RISSER, H. J. YEARIAN AND J. D. HOWE. *Frank. Inst., J.,* **228,** *pp.* 563–579, *Nov.,* 1939.—A description of the construction of the apparatus is given with full details of adjustments of the magnetic field necessary for an intense beam. W. E. D.

***128. Exhaust valve for pneumatic cloud chambers.** L. FUSSELL, JR. *Rev. Sci. Instruments,* **10,** *pp.* 321–322, *Nov.,* 1939.—An air valve designed for the purpose of triggering the expansion of a pneumatic cloud chamber utilizes Bridgman's "unsupported area" seal. The valve is controlled by a magnet constructed from the field coil of an inexpensive dynamic loud-speaker. This design allows vacuum-tube control of forces up to 75 lb. High speed of operation (~ 1/300 sec.) recommends its use with counter control, and its extreme simplicity is advantageous in general work. [See following Abstract.] AUTHOR.

***129. Cloud chamber control circuit.** I. A. GETTING. *Rev. Sci. Instruments,* **10,** *pp.* 323–324, *Nov.,* 1939.—A simple circuit employing neon-filled cold-cathode thyratrons is described for use in controlling cloud chambers. The circuit operates on the standard d.c. line and performs reproducible cycles with great precision and extreme ease of adjustment of time intervals between successive steps of the cycle. [See preceding Abstract.] AUTHOR.

***130. Improved counting-rate meter.** ROBLEY D. EVANS AND R. L. ALDER. *Rev. Sci. Instruments,* **10,** *pp.* 332–336, *Nov.,* 1939.—An improved counting-rate meter circuit is described, whose output meter reads directly the average rate of appearance of pulses in a counter exposed to radioactive substances. Four output scales are provided on a 100-microampere meter, such that full scale corresponds to 7 200, 2 200, 1 450, and 400 counts per min. Even on the highest speed range, the output current is closely proportional to the counting rate over the entire scale. For very low counting rates, an optional register output is provided. AUTHORS.

***131. Direct-reading counting-rate ratio meter.** ROBLEY D. EVANS AND R. E. MEAGHER. *Rev. Sci. Instruments,* **10,** *pp.* 339–344, *Nov.,* 1939.—A multi-staged thermionic amplifier is described, using two discharge counters, and having an output meter which reads directly the ratio of the activity of two radioactive sources. Continuous photographic recording of this ratio for two fractions of a rapidly decaying source therefore provides a direct observation of their relative activity which is invariant with time, even though a mixture of substances having a variety of half-periods is involved. The amplifier holds advantages of greater convenience and higher statistical accuracy over the usual single counter amplifier when dealing with sources having moderate strength and half-periods near the range of five minutes to 1 hr. It is particularly suited to experiments in which such radioactive substances are used as chemical or biological indicators. A portion of the circuit, consisting of three thermionic tubes, has general applicability wherever direct observations are wanted of the ratio of two d.c. currents. AUTHORS.

***132. Experiments with Geiger-Müller counters and associated circuits.** A. L. HUGHES. *Am. Phys. Teacher,* **7,** *pp.* 271–292, *Oct.,* 1939.—An account is given of a Geiger-Müller counting unit specially designed for instructional purposes in an advanced laboratory course. It is so designed that all parts are readily accessible enabling one to measure potentials across, and currents through, various parts of the circuits and to study the effect of changing the values of resistances and condensers. The unit is made up of a Neher-Pickering control circuit, a Reich scaling circuit, and a Pickering recording circuit. This arrangement was chosen because it combined simplicity, tolerance to variations in operating conditions, and instructional value. Experiments with a Geiger-Müller tube and its associated circuits provide an excellent introduction to the study of phenomena characterised by statistical fluctuations, a type of investigation hardly ever undertaken in the normal advanced laboratory course. Various methods for studying statistical fluctuations, with and without scaling, are described. The second half of the paper gives a simplified discussion of the statistics of counters and associated circuits. AUTHOR.

***133. Cause of multiple discharges in a Geiger-Müller counter.** C. H. COLLIE AND F. MORGAN. *Journ. Sci. Instruments,* **16,** *pp.* 369–372, *Dec.,* 1939.—The formation of double kicks in a Geiger-Müller counter has been investigated experimentally. It is shown that they can be produced by the presence of small amounts of xylene vapour in the counter, and that the double kick is due to the release of an electron from the cathode when the xylene ions are discharged 10^{-3} sec. after the first discharge. AUTHORS.

See also Abstracts 1, 2, 68, 245, 272, 274.

RADIATION.

COLORIMETRY.

134. Theoretical colorimetry. J. DOURGNON. *Soc. Franç Élect., Bull.,* **9,** *pp.* 929–957, *Nov.,* 1939.—A general treatment of trichromatic colorimetry from the theoretical point of view, with particular reference to notation and methods of representation. The C.I.E. reference system of colorimetry is described and the procedure for transforming from one system to another is explained. One section is devoted to the hue-and-saturation system of colour description. J. W. T. W.

See also Abstract 42.

ELECTRO-OPTICAL AND MAGNETO-OPTICAL EFFECTS.

135. Ellipsoids of polarization of bonds and octets. SHENG-NIEN WANG. *J. Chem. Phys.*, **7**, *pp.* 1012–1015, *Nov.*, 1939.—By using the method of G. Sachsse [see Abstract 2964 (1935)] the transverse and longitudinal polarizabilities of bonds and octets occurring in simple organic molecules are calculated from the Kerr constants and the degrees of depolarization of compounds in the gaseous state. The results are more reliable and show more regularities than those calculated by Sachsse from his measurements on solutions. AUTHOR.

136. Magnetic rotatory dispersion and refractivity of aqueous solutions of nickel sulphate. R. W. ROBERTS AND S. F. ADAMS. *Phil. Mag.*, **28**, *pp.* 601–613, *Dec.*, 1939.—The Verdet constants and refractivities of two solutions of nickel sulphate have been determined throughout the range 5 780 Å to 2 482 Å. The "theoretical specific rotation" of nickel sulphate in six solutions has been found for wave-length 3 128·9 Å, giving the relation between Δ and W as $\Delta = 3{\cdot}330\,2 \times 10^{-5}$ W $- 0{\cdot}018\,305 \times 10^{-4}$. The dispersion of Δ/W has been calculated, and from the results the contribution to the dispersion, due to the absorption band at 0·395 μ, has been estimated. The dispersion curve of the magnetic rotation in the neighbourhood of this band is asymmetric, in agreement with the theory of van Vleck and Serber for the paramagnetic rotation independent of the temperature. AUTHORS.

137. New magneto-optical phenomenon. Q. MAJORANA. *Ricerca Scientifica*, **10**, *pp.* 783–789, *Sept.*, 1939.—In 1902 the author observed for the first time magnetic birefringence, magnetic dichroism and bimagnetic rotation. In the present paper he summarizes a recent series of experimental researches on the same order of phenomena, from which it appears that the substances endowed with noteworthy magnetic birefringent power, such as the colloidal solutions of iron, undergo under the action of the magnetic field important modifications so far as concerns their absorbing power for ordinary light. J. J. S.

EMISSION.

138. Reaction of the field of a moving electron on itself. A. BELOUSOV. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 6, *pp.* 658–669, 1939. *In Russian.*—The action of the radiation field of a moving electron on the electron itself is discussed on the basis of classical electrodynamics. The exact equation of motion of the centre of gravity of an undeformed electron is found to be a non-linear integro-differential equation. Analysis of this equation shows that in certain conditions it reduces to the usual equation of motion containing the force of reaction of the radiation. Although the reaction force is proportional to the third-order time derivative, the solution involves only two arbitrary constants. D. S.

139. Energy fluctuations in the electromagnetic field. P. MORRISON. *Phys. Rev.*, **56**, *pp.* 937–940, *Nov.* 1, 1939.—Burn and Fuchs [see Abstract 3987 (1939)] have recently pointed out that the energy fluctuations of the electromagnetic field contain terms, coming from the possibility of the emission and re-absorption of pairs of quanta, that do not occur in the energy fluctuations of a Bose gas. There are two such terms. One is a function of the occupation numbers which specify the state of the field, and is a surface term, proportional to the surface area of the volume in which the fluctuations are measured. The second term is a zero-point fluctuation, independent of the number of quanta in the field, and is infinite. The introduction of an essential indeterminacy in the time of measurement reduced the number of high-energy quanta made by the rapidly varying time Fourier components of the charges and currents which make up the bounding walls of the test region, and makes the zero-point term a finite surface effect. With such a time indeterminacy and the use of a test volume of dimensions large compared to the wave-lengths involved, the fluctuations can be made as close as desired to those of the Bose gas. AUTHOR.

***140. Radiation properties of substances between 250°C. and 800°C.** M. PIRANI. *Journ. Sci. Instruments*, **16**, *pp*. 372–378, *Dec.*, 1939.—The paper describes a simple technical method for the comparison of total radiations from samples at high temperatures. Quartz glass is used as an easily reproducible reference standard. An attempt has been made to obtain approximately absolute figures (taking a "black body" as unity) by calculating the emission of the standard substance from measurements of its transmission for different wave-lengths in the infra-red at room-temperatures. Some of the numerical results of the measurements obtained by this method have been put in the form of a graph. AUTHOR.

141. Cosmic-ray measurements below the earth's surface. J. CLAY AND A. v. GEMERT. *K. Ned. Akad. Wet., Proc.*, **42,** 8, *pp*. 672–686, 1939. *In English*.—Intensities of vertical rays were measured by a triple coincidence counter at depths varying from 85 m. to 1 380 m. water-equivalent. Contrary to the usual assumption, it was found that the ratio of the absorption in a given substance to that in water was rather less than the density, being more nearly proportional to the density of electrons, but there is even deviation from this for high elements. Measurements made with 1 m. of Pb between the counters are consistent with the supposition that all the primaries are ionizing rays; also in the region between 219 m. and 311 m. water-equivalent there are secondaries which can penetrate 1 m. of Pb. The manner in which the ratio of secondaries to primaries varies with depth indicates the presence of protons. The half-life of the meson is estimated at 2×10^{-6} sec. W. E. D.

142. Cosmic-ray observations in the stratosphere with high-speed counters. L. F. CURTISS, A. V. ASTIN, L. L. STOCKMANN AND B. W. BROWN. *Bureau of Standards, J. of Research*, **23,** *pp*. 585–595, *Nov.*, 1939.—By a modification of a method reported previously [see Abstract 641 (1938)] observations of cosmic-ray intensity at high altitudes have been made. A Neher-Harper circuit has been used with relatively large Geiger-Müller counters so that 2 000 to 3 000 counts per min. could be recorded by means of radio equipment sent aloft attached to free balloons. The counters were standardized in terms of the radiation from 1 mg. of Ra at a distance of 1 m. and the maximum cosmic-ray intensity was found to be 0·55% of this intensity. This maximum was found to occur at an atmosphere pressure of 60 millibars. A very low intensity at pressures of about 5 millibars, reported in the previous paper, was not observed in any of the 15 ascents in which the data reported in the present paper were obtained. AUTHORS.

FLUORESCENCE AND PHOSPHORESCENCE. LUMINESCENCE AND AFTERGLOW.

143. Phosphorence of plastically deformed NaCl crystals. N. Fedenev. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 5, *pp.* 555–560, 1939. *In Russian.*—The phosphorescent spectrum of plastically deformed NaCl crystals irradiated by X-rays is described for crystals treated in various ways. D. S.

144. Effects of temperature and exposure to X-rays upon triboluminescence. F. G. Wick. *J.O.S.A.*, **29**, *pp.* 407–412, *Oct.*, 1939.—A continuation of previous work [see Abstracts 2550 (1937) and 4934 (1937)]. Experiments have been carried on a number of substances with special attention to fluorites. Of the three types of triboluminescence previously reported it is now established that type (*a*), excited by X-ray or Ra exposure, is similar to the phosphorescence or thermoluminescence and that type (*b*) excited by breaking only and characteristic of the material, is probably a secondary effect due to type (*c*), due to electrostatic discharge. J. E.

145. Cathodoluminescence of luminescent magnesium silicates and related magnesium minerals. E. Iwase. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 938, *pp.* 426–436, *Oct.*, 1939.—The synthetic luminescent materials composed of magnesium silicate were systematically investigated under cathode-ray bombardment. It is pointed out that magnesium silicate with added manganese shows remarkably beautiful, intense red luminescence which is worthy of note especially from the practical point of view. The cathodoluminescence exhibited by some natural magnesium-bearing minerals, e.g. magnesite from Daisekkyo, Manchuria, dolomite from Kuzuu, Tochigi Prefecture and diopside from Kisshu, Korea was spectrographically studied. A brief account is given of the luminescence spectra of diopside and dolomite by considering these minerals as *Mischphosphor*. Chemical analysis was made on the granular carbonate mineral from Tan-yo-men, Korea, and magnesium was found to be one of its main constituents, as was expected from the peculiar colour of cathodoluminescence. Author.

INTERFERENCE, DIFFRACTION AND SCATTERING.

See Abstracts 6, 218.

PHOTOCHEMISTRY (INCLUDING PHOTOGRAPHY).

146. Photodecomposition of cystine in wool. H. A. Rutherford and M. Harris. *Bureau of Standards, J. of Research*, **23**, *pp.* 597–601, *Nov.*, 1939.—The data confirms the hypothesis that the primary action of the radiation, which results in a change in the state of the S and a corresponding lowering of the cystine content, is independent of the moisture in the system. The results indicate, however, that moisture plays an important rôle in the secondary process, namely that involving the evolution of H_2S from the irradiated fibres. It is also shown that decomposition of the cystine resulting from thermal reactions under the conditions of these experiments is negligible. Authors.

147. Degradation of oriented cellulose structures by polarized ultraviolet light. C. W. Mason and F. B. Rosevear. *Am. Chem. Soc., J.*, **61**, *pp.* 2995–3001, *Nov.*, 1939.—Using a silica " pile of plates " polarizer, to give polarized u.v. light, parallel ramie fibres were irradiated, in a cell containing metallic sodium, to eliminate air or moisture that might cause secondary non-directional reactions. With light vibrating crosswise to the fibres, degradation was greater than with vibrations lengthwise, by about 25%, as measured by copper number determined on 10-mg samples From analogy with simpler compounds, it is concluded that degradation of cellulose chains is greatest if they are oriented so that the light vibrates in the direction in which they are most deformable. AUTHORS.

148. Resolving power and structure in photographic emulsion series. A. P. H. TRIVELLI AND W. F. SMITH. *Kodak Research Lab., Comm. No.* 711, *Phot. J.*, **79,** *pp.* 630–634, *Dec.*, 1939.—Empirical relations of a simple exponential type have been found between the resolving power of a photographic emulsion and its size-frequency characteristics, pointing to the very great advantage of fine-grain over coarse-grain emulsions. The resolving power is very little affected by changes in the total number of grains in an emulsion, but is considerably affected by a small average grain size and a small standard deviation of the grain size distribution. [See Abstract 2874 (1939).] AUTHORS.

***149. Photographic sensitometer.** W. M. CADY. *J.O.S.A.*, **29,** *pp.* 470–471, *Nov.*, 1939.—A sensitometer is described which affords a continuous variation of illumination across the sensitive surface. Two intensity-ranges are available, using the same source of light and the same exposure-time; with both ranges, the instrument can give an over-all variation of intensity in the ratio 2 000 : 1. No lenses or moving parts are needed, and the sensitometer is strictly neutral with regard to wavelength. AUTHOR.

See also Abstract 191.

PHOTOMETRY.

150. Precise photometry of composite lights of known spectral distribution. H. KÖNIG. *Helv. Phys. Acta*, **12,** 6, *pp.* 519–535, 1939.—*In German.*—Two lights may be compared with theoretically perfect accuracy if either (a) their spectral energy distributions are the same or (b) the visibility (luminosity) curve of the observer or photometric comparator is that accepted internationally. A third case arises in the comparison of composite lights containing *n* components of known spectral compositions (e.g. discharge lamps) where accurate results may be obtained if comparisons are made by means of photometric comparators fulfilling (n–1) independent conditions. The theory of this third case is worked out and it is shown how the results may be applied in the practical photometry of such composite lights. J. W. T. W.

***151. Employment of Se photocells in precision photometry.** J. TERRIER. *Comptes Rendus*, **209,** *pp.* 300–301, *July* 31, 1939.—Though not in favour for photometry of precision for which visual observations are preferred the author regards it as certain that Se photo-cells can with advantage be employed for the comparison of similarly coloured two luminous standards of incandescence, in spite of the defects of the Se cells which he eliminates in the following manner : (1) The indications of the cell do not vary linearly with the illumination and above all they are not to be trusted—they change with time, temperature, etc. The eye, however, is still worse. In order to cause the cell to furnish a proof of an equality of illumination, and to gain freedom from its untrustworthiness its indications are controlled frequently (e.g. every 2 or 4 sec.) by comparison with a constant test lamp. The cell is exposed alternately to the radiation of the constant test lamp and that of one of the standard lamps to be compared. The distance is regulated so that the cell reacts identically in the two positions. Similarly the other lamp is treated, and the ratio of the intensities is deduced from the measurements of the distances. (2) The cell has not the sensibility curve of the ordinary eye, whence possible error because the spectral components of the radiations are not identical. In the case of incandescent lamps the continuous spectrum is characterized almost entirely by the colour temperature. Se cells are most sensitive to lamps with less high temperature, but for certain special cells (Tungsram) the difference is less than 1/100th between 2 045° K. and 2 360° K. Thus the errors are negligible when lamps are compared whose colour temperature is the same within about 1/10th of a degree. Practical tests of the method described made at the *Laboratoire Central d'Electricité* gave satisfactory results, and the measurements are very rapid. J. J. S.

POLARIZATION.

152. Optical activity dependent on the planar arrangement of the valencies of the 4-co-ordinated palladous atom. A. G. Lidstone and W. H. Mills. *Chem. Soc., J., pp.* 1754–1759, *Nov.,* 1939.—The method employed by Mills and Quibell for the examination of the valency configuration of the 4-covalent platinous atom has been applied to Pd. *iso*Butylenediamino*meso*stilbenediaminopalladous salts (III) have been prepared and resolved into optical antimers by means of *d*- and *l*-diacetyltartaric acids. The molecular rotations $[M]^{15^\circ}_{5461}$ observed for the optically active nitrates were 50·5° and − 50·4°. The optical activity of the nitrates was stable at the ordinary temperature, but on heating it diminished more rapidly than that of the analogous Pt derivatives. The molecular dissymmetry of the complex ion thus demonstrated shows that the valencies of the 4-co-ordinated palladous atom cannot have a regular tetrahedral arrangement and accordingly indicates that they lie in one plane. Authors.

153. Rotatory dispersion and absorption spectra of carboxylic acids and hydrocarbons containing a phenyl or cyclohexyl group. A. Rothen and P. A. Levene. *J. Chem. Phys.,* **7,** *pp.* 975–983, *Nov.,* 1939.—The configurational relationships of aliphatic and aromatic disubstituted carboxylic acids having been established, it was possible to study the vicinal effect of the phenyl group on the carboxyl group. It was found that the effect of the phenyl group is not different from that of a normal hexyl or a cyclohexyl group. This phenomenon is due, perhaps, to the fact that the absorption bands of the phenyl group nearest to the visible region are not optically active. Authors.

See also Abstracts **24, 147, 172, 232.**

REFLECTION, REFRACTION AND DISPERSION.

154. Reflection factor of coal. F. W. Sharpley. *S. Wales Inst. Eng., Proc.,* **55,** 2, *pp.* 158–169, 1939.—Describes the method used to measure the reflection factor of a sample of coal under three conditions of illumination, *viz.* (*i*) normal incidence, 45° reflection, (*ii*) 45° incidence, reflection along normal, (*iii*) 22½° incidence, 22½° reflection. A number of samples were taken from English and Welsh collieries, representing a variety of types of coal. The side used for the reflection measurements was in all cases freshly cut and, as far as possible, it was that side of the sample which originally formed part of the working face when *in situ*. No smoothing or polishing of the surfaces was carried out. The results obtained ranged from 8·3 to 2·9% for condition (*i*), from 10 to 3% for condition (*ii*), and from 88 to 4·8% for condition (*iii*). The last is a condition of specular reflection and a separate investigation under more carefully controlled conditions of incidence and reflection angle was made on one sample with a glossy surface. In this case the reflection factor reached a peak value of 19. Some implications of the results, as they affect the necessary illumination in mines, are pointed out at the end of the paper. J. W. T. W.

155. Anomalous dispersion in Pb vapour. K. Zherebtzova. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9,** 5, *pp.* 566–568, 1939. *In Russian.*—From a study of the anomalous dispersion of Pb vapour the author deduces the ratio of the oscillator strengths of the lines 2 170 and 2 833 Å of the diffuse and sharp series of the Pb spectrum. D. S.

156. Iodine value and refractive index of safflower oil. R. V. Joglekar and S. K. K. Jatkar. *Indian Inst. of Science, J.*, **22A,** 16, *pp.* 219–223, 1939.—It has been shown that the relationship between the iodine value and refractive index of safflower oil hardened by the continuous process is given by the expression $n_D^{60} = 1\cdot4463 + 1\cdot03 \times 10^{-4} \times$ (I.V.) $+ 7\cdot3 \times 10^{-8}$(I.V.)^2. Authors.

***157. Small optics shop.** G. G. Kretschmar. *Am. Phys. Teacher,* **7,** *pp.* 332–334, *Oct.*, 1939.

***158. Testing Cassegrain mirrors.** E. Gaviola. *J.O.S.A.*, **29,** *pp.* 480–483, *Nov.*, 1939.—A new arrangement for testing Cassegrain mirrors is described which does not require the use of large mirrors as auxiliaries. It consists in placing a convergent lens in front of the mirror so as to form a real image of the illuminating pinhole and measuring the resulting aberration. The aberration of the lens is numerically eliminated after an independent measurement with the help of a small plane mirror placed at an appropriate distance. The longitudinal aberration of the Cassegrain alone can also be directly obtained by displacing the small plane mirror. The method permits high precision. It can be applied to any convex surface. [See following Abstract.] Author.

159. Errors of testing and new method for surveying optical surfaces and systems. R. Platzeck and E. Gaviola. *J.O.S.A.*, **29,** *pp.* 484–500, *Nov.*, 1939.—A systematic study of the precision required and of the errors committed in testing parabolic mirrors by the longitudinal aberration and by the transversal aberration methods is made, showing that these methods do not possess in general the necessary accuracy of $0\cdot01\lambda$ per zone. A new method is developed, which consists in determining the *caustic* or line of the centres of curvature of the surface elements. With this method, a precision of better than $0\cdot01\,\lambda$ per zone can easily be obtained. The zones can be comparatively wide. Secondary zones and surface detail can be detected just as well, or ever better than by using a plane mirror in conjunction with the parabolic. The use of master flats is thus superfluous. The experimental procedure is explained and results of actual tests are given. By using a thin wire instead of a knife-edge systematic errors are avoided and higher precision is obtained. The caustic method can be applied to the quantitative test of convex surfaces, like Cassegrain mirrors, to the determination of astigmatism, to the study of single lenses, lens systems, Schmidt correcting plates, etc. Its accuracy does not depend on the value of the aberrations, so that surfaces departing considerably from a sphere can be tested just as well as spherical surfaces. It will thus be possible to figure such surfaces with high precision. [See preceding Abstract.] Authors.

***160. Achromatic objective for use in u.v. microscopy.** B. K. JOHNSON. *Phys. Soc., Proc.,* **51,** *pp.* 1034–1039, *Nov.,* 1939.—The design of a low-power achromatic microscope objective for use in the u.v. region is described. By employing LiF combined with fused quartz, achromatism of the lens system, is obtained for a considerable range of the visible and u.v. spectrum. This greatly facilitates the technique of u.v. microscopy, for it is only necessary to focus the object in visible light and the u.v. will be simultaneously in focus. The use of certain u.v. filters with a modern high-pressure Hg-vapour lamp is also discussed. AUTHOR.

See also Abstiacts **24, 189.**

SPECTROSCOPY.

161. Spectroscopic estimation of Sb in Cu-Al-Sb alloys. S. PASTORE. *Ricerca Scientifica,* **10,** *pp.* 840–844, *Sept.,* 1939.—The author discusses quantitative estimation of Sb in ternary Cu-Al-Sb alloys by Occhialini's method. He gives a plot of line length against Sb content which shows that between 1·7 and 8 % Sb the relation is linear. Despite the simplicity of the apparatus good results are obtained and photography is not essential since the method can be applied visually for rapid work. D. R. H.

162. Number of lines in a series as a function of electron pressure. F. L. MOHLER. *Astrophys. J.,* **90,** *pp.* 429–438, *Oct.,* 1939.—In an intense discharge the higher lines of a series merge into a continuous spectrum at a value of the effective quantum number n_m which depends upon the electron concentration N_e. A previous paper by the author [see Abstract 379 (1939)] gives values of the electron concentration for the Cs discharge for a wide range of vapour pressures and current densities. The number of lines in the D and F series have been determined for this range of conditions. The maximum quantum number for the red component of the D series and for the F series is given by the equation $\log N_e = 23{\cdot}6 - 7{\cdot}5 \log n_m$. This relation agrees well with theoretical results for hydrogenic spectra and has been applied to stellar spectra. For main-sequence A0 stars the electron pressure in atmospheres is $0{\cdot}4 \times 10^{-4}$ at the Balmer limit; $0{\cdot}7 \times 10^{-4}$ at the Paschen limit, and $1{\cdot}8 \times 10^{-4}$ at 4340 Å. The star α Cygni has a pressure of about 1×10^{-6} atm. at the Balmer limit, while for white dwarfs the pressure exceeds 10^{-2} atm. AUTHOR.

163. Ionic depression of series limits in one-electron spectra. D. R. INGLIS AND E. TELLER. *Astrophys. J.,* **90,** *pp.* 439–448, *Oct.,* 1939.—The effect of ionization of the surrounding atmosphere in broadening the high-series terms of the akali spectra so that they form a continuum down to a quantum number n, is discussed theoretically. It is shown that the ion density is proportional to $n^{-7 \cdot 5}$. The effect of the mobility of the electrons is investigated. [See preceding Abstract.] AUTHORS.

164. Transition probabilities for HeI. L. GOLDBERG. *Astrophys. J.,* **90,** *pp.* 414–428, *Oct.,* 1939.—Simple, screening-type wave functions have been utilized to derive general expressions for the line strengths in the 2s — np and 2p — nd series of HeI. The resulting strengths calculated for these series compare favourably with those computed by Hylleraas for the transitions up to $n = 6$. A computation of the radiational damping constants shows that the HeI triplet damping factors are of the order of 100 times smaller than the singlet values, a result that arises from the metastability of the lowest triplet level and from the short wavelength of the fundamental singlet line. The expressions for the discrete f-values have been extended to the continuum by the device of letting $n \rightarrow i\kappa$, where κ is a continuous quantum number according to the method outlined by Menzel and Pekeris. The resulting expressions provide for the determination of the absorption coefficients for bound-free transitions from the 2s and 2p levels. The *f*-sum rule of Kuhn and Thomas-Reiche predicts that the sum of the *f*-values of all transitions from a singly excited level of HeI should equal unity. The rule appears to be satisfactorily obeyed for all but the 2^3S level, for which the sum is 0·849. AUTHOR.

***165. Wide-range intensity measurements in photo-electric spectrophotometry.** W. C. BOSCH AND B. B. BROWN. *J.O.S.A.*, **29**, *pp.* 466-469, *Nov.*, 1939.—Methods of measuring intensity in photo-electric spectrophotometry are discussed, and conditions for maximum reasonably precise utilization of amplifier galvanometer response are experimentally investigated. For a spectrophotometer having four light sensitivity ranges, differing by approximate multiples of ten, it is shown that, if proper grid bias is used on each range, deflection is proportional to incident light intensity within ± 0·5 % for applied grid potentials from 0 to 0·3 V. With a suitably selected galvanometer system, deflections measure light intensities from 1·0 to 10^6 arbitary units over the whole response range of the instrument. It is also shown that for applied grid potentials from 0 to 0·5 V, the deviation from linearity does not exceed ± 1·5 %. AUTHORS.

166. Hyperfine structure and Zeeman effect of the resonance lines of lithium. D. A. JACKSON AND H. KUHN. *Roy. Soc., Proc. A*, **173**, *pp.* 278–285, *Nov.* 28, 1939.—By means of absorption in atomic beams, it has been possible to observe hyperfine structure in the resonance lines of Li 7, and to determine the splitting of the ground state $2S_{\frac{1}{2}}$ with great accuracy. The value found was $0 \cdot 0275 \pm 0 \cdot 0003$ cm.$^{-1}$, giving a nuclear magnetic moment $\mu = 3 \cdot 25$. The hyperfine structure of the π components of the Zeeman effect of the line $2S_{\frac{1}{2}}-2^2P_{\frac{3}{2}}$ of Li 7 could be resolved. Four lines were observed in each component, in agreement with the value $I = \frac{3}{2}$ of the nuclear spin. The multiplet splitting of the 2^2P- term of Li 7 was found to be $0 \cdot 3372 \pm 0 \cdot 0005$ cm^{-1}. The isotope shift of the line $2S_{\frac{1}{2}}-2^2P_{\frac{1}{2}}$ was found to be 0·345 cm^{-1}, and that of the line $2S_{\frac{1}{2}}-2^2P_{\frac{3}{2}}$ about 0·36 cm^{-1}. AUTHORS.

167. Inversion of alkali doublets. G. ARAKI. *Phys. Math. Soc. Japan, Proc.* **21**, *pp.* 508–516, *Sept.*, 1939.—The inversion of doublets of neutral alkali atoms is explained by the fact that the screening constant due to the spin-orbit interaction between the valence electron and atomic core is greater than the atomic number. The general formula of alkali doublets is derived, taking into account the electromagnetic interactions between all atomic electrons. The numerical calculation is carried out for $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4f^2\ F_{3\frac{1}{2},2\frac{1}{2}}$ of Cu. The calculated interval of the doublet is $-4 \cdot 0$ cm^{-1}. which agrees with the observed value $-3 \cdot 6$ cm^{-1}. AUTHOR.

168. Oscillation frequencies of nitrites. D. WILLIAMS. *Am. Chem. Soc., J.*, **61**, *pp.* 2987–2990, *Nov.*, 1939.—The infra-red absorption spectra of $NaNO_2$ and KNO_2 have been studied between 6 and 16μ and absorption bands have been observed at 7·6, 8·2, and 13·3μ. These bands are interpreted as arising from fundamental vibrations of the nitrite group. Force constants and valence angles of the nitrite group are computed by means of the central-force-field approximation. The valence-force-field proves to be an unsatisfactory approximation for the nitrites. The spectrum of HNO_3 is discussed. [See Abstract 3298 (1939).] AUTHOR.

169. Far infra-red absorption spectrum and rotational structure of D_2O molecule. N. Fuson, H. M. Randall, and D. M. Dennison. *Phys. Rev.*, **56,** *pp.* 982–1000, *Nov.* 15, 1939.—An investigation has been made of the spectrum of heavy water vapour (D_2O) in the region from 23μ to 135μ. The instrument used was a self-recording spectrograph of large aperture, using echelette gratings, vacuum thermopile, and a system of filters, shutters, and *reststrahlen* plates to remove higher-order spectral impurity. The radiation path in the spectrograph could be evacuated. From this research the experimental positions and relative intensities of 210 pure rotation absorption frequencies were obtained. Absorption maxima were located with an accuracy of about $0{\cdot}05$ cm^{-1}. Lines $0{\cdot}5$ cm^{-1}. apart were partially resolved, higher resolution and dispersion being of little advantage since the true width of these absorption lines was of this same order of magnitude. The energy levels of a zeroth-order approximation to the D_2O asymmetric rotator molecule were computed through quantum number $j = 11$, and corrected for zero-point vibration and centrifugal stretching in the ground state. A comparison of the positions and intensities of the experimental data with those of the transitions between these " key " levels showed a rather good agreement. These levels were therefore corrected to fit the data, and checked for consistency by means of series regularities and combination relations. In all, 111 distinct energy levels based on the experimental data contrasted with a similar graph of the transitions based on these corrected levels gives a clear picture of the success of the analysis. Authors.

170. Infra-red absorption spectra of AsH_3, AsD_3 and PD_3. E. Lee and C. K. Wu. *Faraday Soc., Trans.*, **35,** *pp.* 1366–1373, *Dec.*, 1939. —The infra-red absorption spectra of gaseous AsD_3, PD_3, and AsH_3 have been studied with a view to obtaining data from which their molecular structure might be calculated. By comparing calculated and observed values of the absorption frequencies it is shown that the valency force field gives a good representation of the actual intramolecular forces. The $4{\cdot}7\mu$ ν_1 fundamental band of AsH_3 has been plotted and a value of $7{\cdot}43 \times 10^{-40}$ gm. cm^2. is deduced for I_A. The rotation structure of this band is complex, probably due to overlapping of ν_3 and interaction between the rotation levels of ν_1 and ν_3. [See following Abstract.] Authors.

171. Infra-red absorption spectrum of methylamine vapour. C. R. Bailey, S. C. Carson and E. F. Daly. *Roy. Soc., Proc. A*, **173,** *pp.* 339–348, *Dec.* 18, 1939.—The infra-red absorption spectrum of methylamine vapour has been examined between 1 and $26{\cdot}5\mu$ with a prism spectrometer. With the assistance of Raman spectra obtained by other workers fundamental modes and combination tones have been assigned. A model for the methylamine molecule analogous to the D_{3h} model for ethane has been shown to offer a reasonable explanation of the spectra. With the inclusion of an indirectly determined low torsional frequency in methylamine, the assignment is capable of yielding a satisfactory calculated value for the specific heat. Authors.

172. Dimensions of PH_3 and AsH_3 molecules and possibility of optically-active derivatives. G. B. B. M. Sutherland, E. Lee and C. K. Wu. *Faraday Soc., Trans.*, **35,** *pp.* 1373–1379, *Dec.*, 1939.—A determination of the dimensions of the PH_3 and AsH_3 molecules has been made from the spectroscopic data available on PH_3, PD_3, AsH_3, AsD_3. Since complete analysis of the rotational structure of the bands is not yet possible, it has been necessary to use the assumption of a valency force field to determine the apical angle from purely vibrational data. Various cross checks with the better known case of ammonia indicate that the method gives results which are not likely to be out by more than 3 %. The dimensions obtained are :—

	XH Bond	XHX Angle	Height of Pyramid
Phospine	1·46 Å	99°	0·67 Å
Arsine	1·56 Å	97°	0·75 Å

These dimensions are next employed in calculating the height of the barrier restricting the passage of the P atom through the plane of the hydrogens, which is practically the same as in NH_3, viz. about 2 000 cm^{-1}. The frequency of inversion is, however, roughly 1 000 times less than in NH_3. Further calculations indicate that the substitution of large massive groups for the hydrogens may well give a molecule for which the frequency of inversion would be sufficiently slow to permit the separation of optically active isomers at sufficiently low temperatures. AUTHORS.

173. Reinvestigation of u.v. band system of CSe. R. F. BARROW. *Phys. Soc., Proc.*, **51,** *pp.* 989–991, *Nov.*, 1939.—The u.v. band system of CSe observed by Rosen and Désirant [see Abstract 3041 (1935)] has been produced in a heavy-current uncondensed discharge through a silica tube into which small quantities of a mixture of Al, Se and a hydrocarbon grease are introduced. The accuracy of the derived constants is considerably increased, as a result of measurements of some 12 band-heads in the region λ2 760 — λ3 054. With the exception of band-heads affected by perturbations associated with $v' = 1$, the data are well represented by $\nu_{\text{head}} = 35\,238{\cdot}0 + (835{\cdot}7u' - 2{\cdot}2u'^2) - (1\,036{\cdot}0u'' - 4{\cdot}8u''^2) - 1{\cdot}3u'u''$, where $u = v + \frac{1}{2}$. The vibrational coefficients in this expression, and the estimated value, 6·8 eV, of the energy of dissociation of the ground state of CSe, are brought into satisfactory relation to those of the neighbouring molecules CO, CS and SiSe. Unsuccessful attempts have been made to develop the corresponding system of CTe. AUTHOR.

174. λ 3400 bands of PH and PD. M. ISHAQUE AND R. W. B. PEARSE. *Roy. Soc., Proc. A*, **173,** *pp.* 265–277, *Nov.* 28, 1939.—The band of PD analogous to the λ3 400 band of PH was photographed in the 4th order of a 10 ft. concave grating. An analysis of its structure was made and the corresponding band-spectrum constants evaluated. The PH band was photographed with the same dispersion and remeasured. The results are: For the initial $^3\Pi_i$ state for PD: $B = 4{\cdot}175$ cm^{-1}.; $D = -1{\cdot}52 \times 10^{-4}$ cm^{-1}.; $A = -115{\cdot}5$ cm^{-1}.; while for PH: $B = 8{\cdot}025$ cm^{-1}.; $D = -5{\cdot}7 \times 10^{-4}$ cm^{-1}.; $A = -115{\cdot}5$ cm^{-1}.; for the final $^3\Sigma^-$ state for PD: $B = 4{\cdot}363$ cm^{-1},; $D = -1{\cdot}20 \times 10^{-4}$ cm^{-1}.; while for PH: $B = 8{\cdot}412$ cm^{-1}.; $D = -4{\cdot}3 \times 10^{-4}$ cm^{-1}. A catalogue of wave numbers with estimated intensities and classification has been prepared, and is available in the archives of the Royal Society. AUTHORS.

175. Infra-red absorption spectra of monosubstituted naphthalenes and the symmetry of naphthalene. J. LECOMTE. *J. de Physique et le Radium*, **10,** *pp.* 423–427, *Oct.*, 1939.—Infra-red absorption spectra of α- and β- $C_{10}H_7X$ [X = OH, NH_2, CH_3, CN, S, F(α), Cl, Br, I, NO_2(α),

$C_{10}H_7(\beta)$] and of α- and β-methyl-naphthyl ketone have been investigated by a self-registering spectrograph in the region 525 to 1 350 cm^{-1}. The results, in conjunction with data from Raman spectra, indicate that the molecule has a plane of symmetry, a centre of symmetry, and a binary axis perpendicular to this plane. The symmetry is D_{2h}. This model explains the spectra of the monosubstituted compounds. The frequencies of naphthalene occur in the spectra of its mono derivatives, usually slightly displaced. The influence of X on the nature of the spectrum is discussed.
W. R. A.

176. Near infra-red absorption spectra of long columns of benzene derivatives. K. Rumpf and R. Mecke. *Zeits. f. phys. Chem.*, **44**, *Abt. B.* 4, *pp.* 299–312, 1939.—The absorption spectra of benzene, phenol, nitrobenzene, aniline, toluene, xylol, naphthalene, tetraline, dekaline, cyclohexanone and dioxane in columns 1 to 3 m. long are investigated. The results indicate that (*i*) the six H atoms of benzene do not lie in the plane of the ring; (*ii*) the coupling of the CH valence vibrations in benzene is very small, so that constitutional influences of various substituents can easily be detected, although combination bands of the CH with other frequencies are very weak. NO_2 and OH groups slightly strengthen, and NH_2 and CH_3 groups slightly weaken, the CH valence. Combination bands with the ring frequencies 1 000, 1 250, 1 430 and 1 600 cm^{-1}. are found; they are also observed as stable ring frequencies in the Raman spectra.
C. B. A.

177. Near u.v. absorption of substituted benzenes. A. L. Sklar. *J. Chem. Phys.*, **7**, *pp.* 984–993, *Nov.*, 1939.—The intensification of u.v. absorption in substituted over unsubstituted benzene is here attributed to the destruction of the sixfold symmetry of the benzene by the partial migration of an electron to the ring or out of it. Toluene, aniline, phenol, and fluorobenzene are treated. The electric moment produced by a migration of an electron from the radical into the benzene ring is calculated by the method of antisymmetric molecular orbitals and the extent of migration by a minimum condition. The results are in agreement with empirical data. It is concluded that a radical will produce a large intensification of the absorption if it has a low ionization potential, a pair of non-bonding P electrons, and a not too large ring-radical distance. On this basis the SH group is predicted to be very effective.
Author.

178. Infra-red absorption by H_2Se, D_2Se and HDSe. D. M. Cameron, W. C. Sears and H. H. Nielsen. *J. Chem. Phys.*, **7**, *pp.* 994–1002, *Nov.*, 1939.—The infra-red spectra of H_2Se, D_2Se and HDSe have been measured and the positions of the three fundamental frequencies for each molecule have been determined. These are: for H_2Se $\nu_1 = 2\,260$ cm^{-1}. $\nu_2 = 1\,074$ cm^{-1}. $\nu_3 = 2\,350$ cm^{-1}.; for D_2Se, $\nu_1 = 1\,630$ cm^{-1}. $\nu_2 = 745$ cm^{-1}. $\nu_3 = 1\,696$ cm^{-1}.; for HDSe, $\nu_1 = 1\,691$ cm^{-1}. $\nu_2 = 905$ cm^{-1}. and $\nu_3 = 2\,352$ cm^{-1}. Interpretation of the observed data has led to the adoption of an obtuse model where the H — Se — H bond angle is slightly in excess of 90°. The H — Se distances are evaluated to be 1·6Å and the H — H distance is equal to 2·3Å. The product relations of Redlich are made use of as a verification of a correct assignment of frequencies and for a correct determination of the band centres.
Authors.

179. Line absorption spectra of rare-earth ions in crystals. E. J. Meehan and G. C. Nutting. *J. Chem. Phys.*, **7**, *pp.* 1002–1011, *Nov.*, 1939.—Absorption spectra of the sulphate octahydrates of Er^{+++},

Dy^{+++}, Ho^{+++} and Tm^{+++} have been obtained at temperatures ranging from 14° K. to 300° K. From the study of the variation in intensity of the absorption lines with temperature, energy levels have been found, in Er^{+++}, at 19, 41 and 86 cm^{-1}. above the normal state. Similar levels have been found in Dy^{+++} at 22 and 57 cm^{-1}. above the lowest. No such low energy states have been found in Ho^{+++} and Tm^{+++}. AUTHORS.

180. Molecular spectra and thermal dissociation of SbI_3 and AsI_3. K. BUTKOV. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 5, *pp*. 561-565, **1939.** *In Russian.*—The molecular absorption spectra of the vapours of SbI_3, AsI_3, and of a solution of SbI_3 in ethyl ether were investigated, and the thermal dissociation of the vapours studied. [See also Abstract 4570 (1934).] D. S.

181. Absorption spectra of vapours in presence of a foreign gas. M. KANTZER. *Comptes Rendus*, **209**, *p*. 675, *Nov*. 6, 1939.—The influence of admixture of various gases (H_2, N_2, O_2, CO_2) on the visible absorption of dry ICl has been studied using pyrex absorption cells of a special design (description to be published later) in which local condensation of the ICl, with consequent decomposition, is avoided by keeping the whole of the gas at a constant temperature. For ICl pressures greater than 0.1 mm. Hg the absorption increases regularly with the foreign gas content, and attains a limiting value dependent on the gas. For ICl pressures less than 0.1 mm. Hg the absorption increases with the foreign gas content, reaches a maximum, and finally attains a constant value. Both the maximum and the limiting value of the absorption depend on the gas. W. R. A.

182. Physico-chemical properties of the chromophore groups vinylene (—CH = CH—) and divinylene (— CH = CH — CH = CH —). E. HERTEL AND H. LÜHRMANN. *Zeits. f. phys. Chem.*, **44**, *Abt. B*. 4, *pp*. 261-285, **1939.**—This paper describes the first of a series of experimental investigations which have the objective of correlating the colours of organic compounds with other physico-chemical properties of the molecule. By means of kinetic measurements and data already accummulated, it has been found possible to analyze completely the absorption spectra of stilbene, diphenylbutadiene and their substitute derivatives. The field inner effects of the styryl and byryl groups lies between those of H and halogen, from which it is concluded that their colour effects are also small. The ability of the vinylene—and divinylene groups to transfer their inner field effects is very small, and these groups have two characteristic absorption regions which are found in all stilbene and diphenylbutadiene derivatives. Substituents in the benzene nucleus produces alterations in the absorption regions of the groups, which are in the order H, OCH_3, $N(CH_3)_2$, NO_2 for long waves. The transportation of the O atom of the OH group in p-nitro-p-hydroxystilbene into the ionic state displaces the absorption region towards the red but does not produce a new absorption zone. The unsaturated negatively charged oxygen ion is not a chromophore. Substituents such as the nitro-and dimethylamino-groups produce a dipole moment with consequences more complicated then can be explained on a simple electrostatic theory. The theories of inner molecular ionide colours and amphoteric auxochromes are critically examined.
H. H. Ho.

183. Colour and constitution of organic compounds in the light of modern physical theory. T. FÖRSTER. *Zeits. f. Elektrochem.*, **45**, *pp*. 548-573, *July*, 1939.—A review of the present position of the theory. In recent years the foundations have been laid through the systematic investigation of the absorption of simple compounds in the visible, and especially in the u.v. region. The newly established quantum-mechanical valency theory provides the theoretical mechanism for treating the problem. So far, one can say that a qualitative stage of explanation has been reached. An introduction discusses the characterization of colour-properties. A short review is given of pre-quantum theories, mainly empirical. They are important, since parts are found later to be valid. The quantum-mechanical valency-theory is discussed, and applications made to particular problems. A. C. M.

184. Method of obtaining expanded secular equation for vibration frequencies of a molecule. E. B. WILSON, JR. *J. Chem. Phys.*, **7**, *pp.* 1047–1052, *Nov.*, 1939.—A method is described for obtaining the secular equation for the vibration frequencies of a molecule directly in expanded form, i.e. as an algebraic rather than a determinantal equation. The force constants occur literally and the masses may occur either literally or numerically, as desired. The symmetry may be employed as usual to factor the secular equation. Several methods of obtaining approximate roots are described for which the expanded form is particularly suitable. Finally, an example, the non-linear general triatomic molecule, is worked out algebraically. AUTHOR.

185. Rotation-vibration energies of tetrahedrally symmetric pentatomic molecules. Parts I and II. W. H. SHAFFER, H. H. NIELSEN AND L. H. THOMAS. *Phys. Rev.*, **56**, *pp.* 895–907, *Nov.* 1, *and pp.* 1051–1059, *Nov.* 15, 1939.—In Part I a complete theory for the rotation-vibration energies of tetrahedrally pentatomic molecules has been derived to a second degree of approximation for certain vibration states. In this discussion the elements of the matrix H are given for the states $\mathrm{V}_1\nu_1$, ν_2, $V_1\nu_1 + \nu_3$, $V_1\nu_1 + \nu_4$, $\nu_2 + \nu_3$ and $\nu_2 + \nu_4$. The selection rules governing what transitions may take place have been determined with relations for the intensities.In Part II a general discussion of a method which may be used to obtain the first-order Coriolis splitting of the harmonic and combination states of ν_3 and ν_4 is presented. The method is applied to obtain these splittings of $2\nu_3$, $2\nu_4$ and $\nu_3 + \nu_4$ and to derive the stabilized wave functions for these states. With these functions the selection rules and the elements of the matrix of the second-order Hamiltonian $H^{(2)\prime}$ have been calculated for these states. AUTHORS.

186. Band spectra of cathodoluminescence. S. T. HENDERSON. *Roy. Soc., Proc. A*, **173**, *pp.* 323–338, *Dec.* 18, 1939.—A photographic method is used to examine the emission bands of various fluorescent materials excited by cathode rays. Single bands given by ZnS or ZnS.CdS agree closely with the Gauss error curve, except at the outer edges where limits to the emission must occur. Approximate graphical analysis gives adequate resolution for more complex bands. Each activator metal produces a band in some characteristic position which varies only slightly with varying preparative methods and activator contents, except when the activator is reduced to very small amounts. The effects of lowering the temperature, and of changing to u.v. excitation are described. A simple relation is demonstrated between band position and composition in the ZnS.CdS series, and the electronic transitions responsible are briefly considered in this case, and also for some Mn-activated materials. AUTHOR.

187. Raman spectra of fused nitrates. P. A. MOSES. *Indian Acad. Sci., Proc. Sect. A*, **10**, *pp.* 71–76, *Aug.*, 1939.—Clear and intense Raman spectra of fused Na, K and Al nitrates have been obtained and reproduced in the paper. Each one of the spectra has been separated into the horizontal and vertical components by the use of a suitably oriented double-image prism. The depolarization factors of the various Raman lines are given. The large degree of polarization exhibited by the 1 050 cm^{-1}. line, corresponding to the symmetric expansion and contraction of the nitrate ion, limiting value of depolarization exhibited by the 700 and 1 400 cm^{-1}. lines corresponding to the two degenerate modes of oscillation of the NO_3 ion and the partial polarization exhibited by the overtone line are amongst the noteworthy results. The overtone line (1 660 cm^{-1}.) itself has been recorded for the first time in molten nitrates in the present investigation. The fact that it is a well polarized line is also a new result. The distribution of intensity within the wing accompanying the Rayleigh line λ 4 046 in fused $NaNO_3$ has been studied. The wing starts with a maximum intensity at the centre and fades off in a manner which is very similar to that obtained in common liquids. Different portions of the wings in the nitrates studied are found to be depolarized to the extent of 86%, in agreement with theory. AUTHOR.

188. Continuous wings occurring in Raman effect. K. BAPAYYA. *Indian Acad. Sci., Proc. A*, **10**, *pp.* 253–261, *Oct.*, 1939.—Certain features characteristic of the continuous wings occurring in the Raman spectra of liquids are studied. It is concluded that besides the optical anisotropy, other physical properties of the liquid such as its viscosity and dipole association play a prominent part in determining the intensity of these wings. No separated maximum could be detected in the wing obtained with liquid benzene even at a temperature of 200° C. The results are discussed in the light of the existing literature. AUTHOR.

***189. Monochromators and auxiliary apparatus.** J. STRONG. *Indust. and Engin. Chem.*, (*Analytical Edition*), **11**, *pp.* 563–567, *Oct.* **15, 1939.**—The developments are indicated which have followed in astronomical and meteorological instruments as the result of the discovery and preparation of new materials by the chemist and the discovery of new properties, effects and techniques by the physicist. (1) Glass surfaces are not ideally suited for astronomical mirrors and lenses, the reflection coefficient being too low for the former and too high for the latter. The reflection coefficient can, however, be altered at will by deposition of thin surface films. Thus, an Al film gives a glass mirror a reflectivity of approximately 90% throughout the entire useful spectrum ; a thin Ca fluorite film on a lens surface eliminates 90% of the transmission losses due to reflection. Surface films have been applied to increase the efficiency of monochromators with elimination of the expensive roof prisms. Graphs show the reflectivity of efficient metals (Ag, Al, stellite, speculum) as a function of the wavelength. The principle of metal-coated mirrors and lenses has been applied to the devising of a double-quartz monochromator for O and HO determinations (described in detail). (2) The growing of large synthetic crystal of alkali halides for prisms in connection with infra-red (KCl, KBr, Kl) and u.v. and visible spectroscopy (NaF, LiF) has become an important industry. MgO is useful for making shutters in connection with the infra-red. Synthetic thermoplastics (Lucite and Pexiglas), the surfaces of which do not require optical working with abrasives and rouge, are used for unbreakable spectacle lenses and sun glass (3) The improvement of the sensitivity of thermopiles and allied radiometric devices is discussed, and the advantage of the Schmidt principle in optical design indicated. Further application of non-reflecting surface films are illustrated. W. R. A.

***190. Apparatus for long optical path in restricted space.** F. T. Rogers, Jr. *J.O.S.A.*, **29**, *p.* 479, *Nov.*, 1939.

See also Abstracts 153, 209.

VISION.

***191. Fundus photography without cycloplegics.** K. L. Stone and M. L. Pool. *J.O.S.A.*, **29**, *pp.* 463–465, *Nov.*, 1939.—With the use of the new H6 water-cooled 1 000-W mercury arc lamp, two polaroids, a new fast film of Weston rating 140, and a simple optical system photographs of the fundus of the eye have easily been made without the use of drugs that dilate the pupil. Authors.

X-RAYS.

192. Strong lines of L-spectrum of tungsten (74). S. Rouault. *Comptes Rendus*, **209**, *pp.* 650–651, *Oct.* 30, 1939.—The L-spectrum of W is measured with a Cauchois spectrograph using a transmission mica curved to 40 cm. radius. The tabulated values for the strong lines reveal a number of deviations from those obtained by Friman and by Idei. C. B. A.

193. Element 87 (Moldavium, Ml). H. Hulubei. *Comptes Rendus*, **209**, *pp.* 675–678, *Nov.* 6, 1939.—Processes deemed likely to concentrate this element applied to various minerals, etc., likely to contain it, e.g. pollucite, beryl, lepidolite, autunite and various commercial samples of salts of Rb and Cs, showed in some cases an undoubted strengthening of the line Lα, attributable to Ml. Results with autunite were the most hopeful. [See Abstract 109 (1940).] C. A. S.

See also Abstracts 11, 12, 13, 278, 282.

HEAT.

CALORIMETRY.

See Abstract 197.

CONDUCTION.

194. Problem in heat conduction. C. J. Tranter. *Phil. Mag.*, **28**, *pp.* 579–583, *Nov.*, 1939.—The method used for the solution of problems involving the conduction of heat from one medium to another is similar to Carslaw's method of contour integrals, but is applicable to cases in which temperature discontinuities occur at boundaries. The modification consists in the inclusion of a term $\phi e^{-\kappa\alpha^2 t}$, where ϕ is the initial temperature difference between the media, κ is the diffusivity of the medium at temperature ϕ, t is time and α the complex variable, in one of the functions assumed for the temperature. The cases solved by the method are (*i*) two semi-infinite solids of different materials in contact along the plane $x = 0$, initial temperature ϕ for $x < 0$ and 0 for $x > 0$; (*ii*) semi-infinite slab at temperature ϕ, placed in an infinite medium of different material, initially at zero temperature. R. W. P.

195. Accidental deviations in the conduction of heat. L. S. ORNSTEIN AND J. M. W. MILATZ. *Physica*, **6**, *pp.* 1139–1145, *Dec.*, 1939. *In English.*—The fluctuations in the conduction of heat and analogous problems are described by adding a term of a fortuitous character to the differential equation analogous to that in the Langevin-Einstein theory of Brownian movement. The mean values of this term can be determined from thermodynamical considerations. The correlation of the accidental deviations is calculated. The treatment is valid for any state of the system. AUTHORS.

196. Theory of thermal conductivity of dielectric crystals. S. TKACHENKO AND J. FRENKEL. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 5, *pp.* 570–577, 1939. *In Russian.*—A theory is given for the processes of equalization of temperature in a one-dimensional chain of atoms, and for this simple model, an expression for the thermal conductivity is obtained in terms of the elastic constants. A critical review of previous theories is also given. [See also Abstract 3515 (1939).] D. S.

CONVECTION.

197. Effect of variable specific heat of gases on the quantities involved in heat transmission between liquids and gases. W. J. WALKER. *Phil. Mag.*, **28**, *pp.* 596–599, *Nov.*, 1939.—The problem discussed is that of heat transfer between hot gases and liquids through the walls of circular tubes. The assumption is made that the specific heat of a gas increases linearly with temperature, and the relevant equations are then derived for the following cases:—(*i*) hot gases cooling while liquid is evaporating at constant temperature; (*ii*) parallel flow of liquid and gases, both media changing in temperature; (*iii*) as (*ii*), but for counterflow. R. W. P.

DILATATION.

***198. Interferometric measurement of dimensional changes in rubber.** L. A. WOOD, N. BEKKEDAHL, AND C. G. PETERS. *Bureau of Standards, J. of Research*, **23**, *pp.* 571–583, *Nov.*, 1939.—The interferometer method for the measurement of small dimensional changes is adapted here to measurements on soft rubber. A detailed description is given concerning the preparation of specimens, the apparatus, the procedure, and the calculations necessary for the application of this method. Particular emphasis is placed on the measurement of thermal expansivity and the dimensional changes involved in transitions between the different forms of rubber. The lower limit of temperature is set only by the refrigerating liquid, temperatures as low as − 185°C. being utilized. The upper limit of temperature is set only by the rubber itself. Results obtained in a study of the expansivity and transitions of " stark " (frozen) rubber are given as an illustration of the application of the method. Other possible applications are the measurement of the swelling of rubber by vapours and the determination of stress-strain relations under compressive loads. The chief limitation of the application of this method to rubber arises from the plastic flow of unvulcanized rubber at elevated temperatures. The method also possesses the inconvenience of requiring continuous observations. As compared with alternative methods of measuring small dimensional changes, the method possesses advantages arising from its high sensitivity, from the small size of the specimens required, from the ease of obtaining temperature equilibrium, from the absence of a confining liquid, and from the simplicity of the calculations. AUTHORS.

See also Abstracts 27, 55, 206.

FUSION AND SOLIDIFICATION.

199. Molecular statistical theory of melting. S. BRESLER. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 6, *pp.* 711–721, 1939. *In Russian.*—After a review of the experimental facts about molecular structure of liquids, the author develops a qualitative theory of the melting of solids, based on the ideas of order and disorder introduced by Bragg and Williams. [See Abstract 3107 (1934).] D. S.

TEMPERATURE.

***200. Effective wavelength for calibration of disappearing-filament optical pyrometer.** F. A. CUNNOLD. *Phil. Mag.*, **28**, *pp.* 588–591, *Nov.*, 1939.—A discussion is given of the question of the true value to be assigned to the effective wavelength throughout the calibration of a disappearing-filament optical pyrometer. The starting point for the calibration was the temperature of melting gold (1 336° K.), and extrapolation from this point was effected by means of rotating sectors and a tungsten strip-lamp. The formula for extrapolation was derived from Wien's law $E\lambda \cdot d\lambda = C_1 x^{-5} e^{-C_2}/\lambda T$, where $E\lambda$ is the spectral energy of the radiation from a black body at temperature T for a wavelength λ, and C_1 and C_2 are constants. The relation found is the same as that derived by Foote [see Abstract 701 (1916)] in considering the effective wavelength to be used when extrapolating between black-body temperatures T_1 and T_2, but in the expression derived by the author the temperatures are not the true temperatures of the filament but the colour temperatures. J. J. S.

***201. Optical pyrometer for general use.** J. G. HAGEDOORN. *Physica*, **6**, *pp.* 1126–1128, *Dec.*, 1939. *In English.*—The construction of an optical pyrometer with the highest possible transmission is described. It has a large field of view and such a magnification that it is also suitable for measuring the brightness of very small objects. The principal new idea employed consists of the use of two diaphragms instead of one. This makes it possible to use an aperture 3 to 4 times larger. AUTHOR.

THERMODYNAMICS.

202. Fluctuations, thermodynamic equilibrium and entropy. E. C. KEMBLE. *Phys. Rev.*, **56**, *pp.* 1013–1023, *Nov.* 15, 1939.—To eliminate exceptions to the second law due to fluctuation phenomena, etc., the following changes are necessary. Firstly the laws of thermodynamics must be stated in terms of Gibbsian ensembles rather than of individual systems. Secondly the conception of the experimental procedure required for producing states of thermodynamic equilibrium must be sharpened. It will not suffice to isolate the system and wait. It is necessary to have the positive stirring action of thermal contact with a thermostat. Using the new definition of thermal equilibrium statistical mechanics can be placed on a more satisfactory footing by showing that the thermostat experimental procedure leads to the canonical ensemble and maximizes v. Neumann's microscopic entropy. (Details of this proof appear in a succeeding paper.) Difficulties with his macroscopic definition of entropy are avoided by showing that his original microscopic definition is satisfactory when used in conjunction with a proper operational definition of thermodynamic equilibrium. In conclusion the second law of thermodynamics is derived from quantum statistics on the basis of the microscopic definition of entropy. AUTHOR.

203. Van der Waals potential in helium. H. MARGENAU. *Phys. Rev.*, **56**, *pp*. 1000–1008, *Nov*. 15, 1939.—Part I is an investigation of the fundamental question concerning the additivity of first-order exchange and second-order van der Waals potentials. The method employed is a variational one which allows both first- and second-order exchange effects to be calculated simultaneously with the second-order attractive terms. It is shown that the assumption of additivity is entirely false for atomic H, but that it is almost legitimate for He. By extrapolation one might conclude it to be quite safe for heavier structures. Part II is a redetermination of the numerical values occurring in the attractive part of the potential, based on the use of oscillator strengths (*f* values) which are adjusted to give the best value for the atomic polarizability of He. It appears that the value of the dipole-dipole coefficient in the Slater-Kirkwood formula has been too high. The final result for the van der Waals potential seems on the whole to be consistent with independent determinations of this quantity from empirical data. AUTHOR.

204. Phase transitions. J. E. MAYER AND S. F. STREETER. *J. Chem.Phys.*, **7**, *pp*. 1019–1025, *Nov*., 1939.—H-T and V-P curves for various types of phase transitions are shown. In second-order transitions a discontinuity in the curvature of the free energy occurs. It appears to follow that some change in the system must be occurring in the phase of high heat capacity, and that this change is such that it has gone to completion at the transition, so that an extrapolation of the phase is meaningless. It is shown that it is extremely difficult uniquely to prove, by calorimetric or equation-of-state data alone, the presence of an anomalous first-order transition, in which heat capacity and compressibility approach infinity continuously as the transition is approached. This type of transition can be distinguished by obtaining two phases of differing density in equilibrium, or by sound-velocity measurements. A tentative discussion of phase transitions, based on a suggestion of Frenkel, is given. It is shown that the factors determining the type of transition can be partially unravelled. A positive surface free energy between the phases necessitates a simple first-order transition. The relation of the Band and Frenkel developments, for an imperfect gas, to the method based on Ursell's development is discussed, and it is shown that the two methods are not identical.
AUTHORS.

205. Statistical mechanics of condensing systems. Part VI. Treatment of a system of constant energy. S. F. STREETER AND J. E. MAYER. *J. Chem. Phys.*, **7**, *pp*. 1025–1038, *Nov*., 1939.—The equations for the thermodynamic functions of an imperfect gas up to and including the pressure of condensation, are calculated for a one-component system consisting of chemically saturated molecules. The method starts with the calculation of the phase volume available to a system below a given energy. The thermodynamic functions are expressed in terms of integrals over the configuration space of a few molecules, the integrands involving the mutual potentials. The equations derived are formally equivalent to those derived in the previous papers in this series, using the Gibbs method. [For Part V see Abstract 1731 (1939).]

206. Compressibilities and expansion coefficients of gases at low pressures, and their relation to molecular volume. J. B. M. COPPOCK. *Roy. Soc., Proc. A*, **173**, *pp.* 201–211, *Nov.* 28, 1939.—A linear relation is shown to exist for non-polar gases at low pressures between their compressibilities and expansion coefficients and the corresponding molecular volumes. It is suggested that the nearest distance of approach of such gaseous molecules at low pressures is dependent on their size and is not a uniform amount as represented by an envelope of about 0·5 Å thick. Additional data have been calculated for certain hydrocarbons and the behaviour of some of them discussed in the light of their spatial structure. AUTHOR.

207. Theory of equation of state. S. TKACHENKO. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 5, *pp.* 578–585, 1939. *In Russian*—Using the method of Kahn and Uhlenbeck [see Abstract 2512 (1938)] the author calculates an equation of state. The isotherms agree with Andrews' experimental curves. D. S.

208. Specific heat of a monatomic liquid. W. J. ARCHIBALD. *Phys. Rev.*, **56**, *pp.* 926–932, *Nov.* 1, 1939.—The partition function for an atom in a monatomic liquid is evaluated by assuming that the atom is constrained by its nearest neighbours to move in a spherical region, and that the potential energy of the atom at any point within this region can be found if the law of force between two atoms is known. On the basis of this partition function an expression for C_v is derived. The theory is checked by a comparison of the experimental and theoretical values of C_v for liquid argon. AUTHOR.

209. Theory of rotational transformations. K. SCHÄFER. *Zeits. f. phys. Chem.*, **44**, *Abt. B.* 2, *pp.* 127–162, 1939.—This paper continues previous work [see Abstract 1723 (1939)] on the influence of an inner field upon the rotation of condensed H_2. Based on the idea of a common orientation of coupled rotators, a theory has now been developed for rotational transformations. This theory in many respects is similar to the theories of Bethe, Williams and Peierls on the order states in mixed crystals, but deviates therefrom, where the energy is to be treated with rrespect to the degree of orientation. It is shown that with rotational transformations not only should potential energies be taken into account but also quantum states and eigenvalues. The new theory permits a general understanding of a series of peculiar phenomena observed in rotational transformations, e.g. the remarkable behaviour of CD_4 at the lower transformation point on the addition of CH_4 and the frequent appearance of thermal hysteresis. H. H. HO.

210. Thermodynamic study of Zn-Sb system. B. DEWITT AND H. SELTZ. *Am. Chem. Soc., J.*, **61**, *pp.* 3170–3173, *Nov.*, 1939.—The activities and partial molal relative heat contents of Zn and Sb in their liquid melts have been determined over the entire concentration range. The solid solubility of Zn in Sb has been calculated. The free energies and heats of formation and the entropies of ZnSb, Zn_3Sb_2 and Zn_4Sb_3 have been evaluated. The heat of fusion of Zn_3Sb_2 has been calculated. AUTHORS.

211. Properties of long-chain compounds as functions of chain length. M. L. HUGGINS. *Kodak Research Lab. Comm. No.* 733, *J. Phys. Chem.*, **43**, *pp.* 1083–1098, *Nov.*, 1939.—From considerations which are largely qualitative in nature certain conclusions have been reached regarding the variation with chain length of various properties—heat content, entropy, heat of fusion, heat of vaporization, vapour pressure—of long-chain compounds at constant temperature. With the aid of experimental heat capacity data, expressions have been derived for the dependence on chain length of the melting point, heat of fusion and entropy of fusion at the melting point, and heat of vaporization at the boiling point. The variation of boiling point with chain length has also been briefly discussed. The conclusions reached have been tested, where possible, with experimental data for normal paraffin hydrocarbons. AUTHOR.

212. Thermodynamics of acid-base equilibria. D. H. EVERETT AND W. F. K. WYNNE-JONES. *Faraday Soc., Trans.*, **35,** *pp*. 1380–1401, *Dec.*, 1939.—The experimental data for the electrolytic dissociation of weak acids have been subjected to a careful analysis from which are obtained values of ΔG^0, ΔH, ΔS^0, and ΔC_p for the various equilibria. It is noteworthy that for the ionisation of uncharged acids, such as acetic acid, the values at room temperature of ΔS^0 and ΔC_p are usually small. The sign and magnitude of the heat capacity change is to be explained by the orientation of solvent molecules around the ions. The authors have also considered in general terms the relationship between the molecular structure and the various thermodynamic quantities and have shown that, for a proper comparison of the strength of acids, it is necessary to take into account not merely the dissociation constants at a particular temperature but the values of all the thermodynamic functions. AUTHORS.

213. Thermodynamic properties, conductivity and diffusion of a typical colloidal electrolyte. P. VAN RYSSELBERGHE. *J. Phys. Chem.*, **43,** *pp*. 1049–1062, *Nov.*, 1939.—Freezing point and conductivity data for aqueous solutions of lauryl-sulphonic acid are interpreted on the basis of an " average inclusive micelle," whose size and charge vary with concentration and in terms of which the solution is considered as ideal, assuming the sole constituents of the solution at all concentrations to be free H-ion and this " average micelle." The Nernst formula for the diffusion coefficient of an unsymmetrical electrolyte is applied to this average micelle, and the main features of the experimental diffusion curve are thereby reproduced. Some predictions are made as to the variation of transport numbers with concentration. The possibility of decomposing the average micelle into ionic and neutral micelles is discussed. AUTHOR.

See also Abstracts 8, 31, 52, 214.

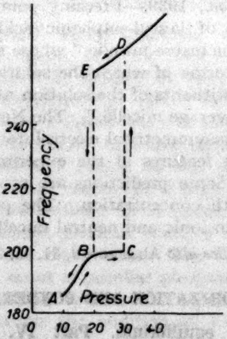
VAPORIZATION AND CONDENSATION.

214. Vapour-liquid equilibrium. Part IV. Carbon tetrachloride—cyclohexane mixtures. G. SCATCHARD, S. E. WOOD AND J. M. MOCHEL. *Am. Chem. Soc., J.*, **61,** *pp*. 3206–3210, *Nov.*, 1939.—The vapour-liquid equilibrium pressure and compositions of carbon tetrachloride-cyclohexane mixtures have been measured at 40 and 70° over the whole composition range, and at 30, 50, and 60° for approximately equimolal mixtures. The densities have been determined at 25°. These measurements have been expressed analytically, and corresponding equations derived for the thermodynamic functions, including the energy and entropy of mixing at constant total volume. The dependence upon composition agrees with the predictions of the simple theory. The deviation from regularity is relatively large but most of it is explained by the volume change on mixing. The unexplained entropy increase on mixing is only one-thirteenth as large as for benzene-cyclohexane mixtures. [For Part III see Abstract 1731 (1939).] AUTHORS.

ACOUSTICS.

215. Absorption of sound in solid crystals. S. TKACHENKO. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 5, *pp.* 622–624, 1939. *In Russian*—The author extends his previous theory of damping of vibrations in crystals [see Abstract 3515 (1939)] to obtain an expression for the absorption of sound. D.S.

216. Stability of sound emitted by a pipe with vibrating reed at constant pressure. L. AUGER. *Comptes Rendus*, **209**, *pp.* 508–509, *Sept.* 25, 1939.—A reed of length 3·8 cm. is adapted to a cylindrical brass pipe of 43 cm. The proper frequency number of the pipe considered as drone (bass-pipe) is about 198. When the pressure increases from zero the tracing point [see fig.] of the frequency of the system follows the arc ABC. The sound takes an agreeable humming tone, starting only from B, corresponding exactly to the frequency number. The amplitude of the tongue then quickly becomes much diminished. When the pressure passes from 19 to 30 cm. of water the frequency curve has a stretch BC, slightly rising, while the extremity of the tongue keeps the same amplitude of vibration. For a pressure of 30 cm. of water the tracing point rises from C to D upon the curve of the reed vibrating in the wind, The amplitude of the reed is nearly doubled. The tone becomes sharp: the sound of the reed is predominant. The pipe may be withdrawn without modifying sensibly the tone of the sound: the pipe has ceased to belong to the acoustic domain of the reed. If then the pressure is diminished the frequency decreases regularly following the curve DE, the tone remaining that of a reed sound. For the pressure of 19 cm. the tracing point falls sharply to B at the starting point of the stretch BC: the sound becomes agreeable. The frequency then decreases following the arc BA, when the pressure diminishes, and for a pressure of 8 cm. the pipe ceases to speak. J. J. S.



217. Temperature dependence of velocity of ultrasound in liquids. P. Prosorov and V. Nozdrev. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 5, *pp.* 625–629, 1939. *In Russian.*—The authors describe and discuss the results of their experiments on the velocity of ultrasound in organic liquids, and water as a function of temperature from −70° C. to 110° C. D. S.

***218. Supersonic stroboscope for measuring sound wavelength in liquids.** F. E. Fox and G. D. Rock. *Rev. Sci. Instruments*, **10**, *pp.* 345–348, *Nov.*, 1939.—A stroboscopic method discussed by Bär for using a sound wave as a light shutter and viewing the same wave train with the modulated light is modified so as to permit observations to be made with a very simple optical system without lenses. This results in a method of measuring relative or absolute acoustic wavelengths in liquids with a precision limited only by that of measuring lengths of the order of 1 m. and the spacing of lines on a photographic plate. Authors.

***219. The synthephone.** C. A. Culver and D. T. Williams. *Rev. Sci. Instruments*, **10**, *pp.* 319–321, *Nov.*, 1939.—A new form of apparatus has been developed by the use of which it is now possible to synthesize musical and other sounds from their elemental components. The basic unit in this equipment is an electrostatic alternator. The new device, which is useful in the study of problems in the field of musical acoustics, has been named a "synthephone." Authors.

ELECTRICITY AND MAGNETISM.

ALTERNATING-CURRENT NETWORKS.

See Abstract 276.

CONDUCTION AND DISCHARGE IN GASES.

220. Theory of current in a vacuum. S. Belljustin. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 6, *pp.* 742–759, 1939. *In Russian.*—The motion of electrons with equal initial velocities between two infinite phase parallel electrodes is discussed and expressions are given for the distribution of potential, the field, space-charge and time of travel of the electrons. D. S.

221. Measurements of mobility of potassium ions at high field intensity and low pressure. A. V. Hershey. *Phys. Rev.*, **56**, *pp.* 908–915, *Nov.* 1, 1939.—The mobility of K ions, H_2, N_2, and A has been measured by the Townsend method, in which a beam of ions is deflected by a magnetic field. When the mobility is reduced to 760 mm. of Hg and 20°C. it should be expressible as a function of the ratio of electric intensity E to the pressure p. This is true at the highest pressures investigated but not at the lowest, apparently because of a breakdown in the method. At small values of E/p the results agree to within a few per cent with the measurements by the Tyndall and Powell method. As E/p is increased, the mobility is at first constant. It then rises, passes through a peak, and finally falls. Pronounced peaks appear in the curves for H_2, N_2, and A but not for He. The mobility is constant only in weak fields where the ions and molecules interact with a frequency which is independent of the drift velocity of the ions. The rise in mobility with increase in E/p may be interpreted as the result of a decrease in the effectiveness of the forces of attraction between the ions and molecules. As the drift velocity exceeds the thermal velocities of the molecules, the collision frequency becomes greater, and the mobility finally falls. Langevin's theory of mobility may be generalized to express the variation with E/p. It is in qualitative agreement with the experimental results, but fails to account for more than a suggestion of the peaks. They are accounted for, however, by a generalization of Hassé and Cook's theory. The experimental data are bracketed by the two theories. [See following Abstract.] AUTHOR.

222. Theory for mobility of ions of high velocity. A. V. HERSHEY, *Phys. Rev.*, **56**, *pp.* 916–922, *Nov.* 1, 1939.—The theories of Langevin and of Hassé and Cook for the mobility of ions in weak fields have been generalized to fields of any strength. The random energy of the ions is assumed to have a Maxwellian distribution, and the drift and random energies are both evaluated by momentum and energy balances. [See preceding Abstract.] AUTHOR.

223. Electron emission under action of positive ions. L. NEMENOV AND A. FEDJURKO. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 5, *pp.* 532–533, 1939. *In Russian.*—Electron emission was investigated from an Al surface under the action of a monochromatic beam of $^7Li^+$ ions of energies between 3 and 30 ekV. The electron energies were measured with the help of retarding potentials, and the maximum energy was found to increase with the energy of the bombarding ions. D. S.

See also Abstracts 127, 128, 129, 130, 131, 132, 133, 274.

CONDUCTION IN SOLIDS AND LIQUIDS.

***224. Vacuum-tube circuit to measure logarithm of direct current.** R. E. MEAGHER AND E. P. BENTLEY. *Rev. Sci. Instruments*, **10**, *pp.* 336–339, *Nov.*, 1939.—A circuit, using a single tube, and having an output voltage which is proportional to the logarithm of a d.c. input, is described. The input current range extends from less than 10^{-7} to 10^{-5} A if a closely linear logarithmic relationship is desired; and from 10^{-8} to 10^{-3} A if only an approximately logarithmic characteristic is necessary. Because the circuit depends for its operation on a fundamental physical law (the Maxwellian distribution of velocities of the thermo-electrons emitted from a hot cathode), its characteristics are constant and predictable. AUTHORS.

225. Rectifying effect of semiconductors with blocking layers. S. PEKAR. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 5, *pp.* 534–539, 1939. *In Russian.*—The author develops a theory of the rectifying action of semiconductors with blocking layers. The distribution of potential and space charge in a semiconductor carrying a current is discussed, and the characteristic curve and coefficient of rectification are deduced. The order of magnitude of the frequency at which frequency dependence of rectification should occur is calculated. The theory is found to agree well with experiment. D. S.

226. Intermediate state for a superconducting ellipsoid. I. NAKHUTIN. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 6, *pp.* 708–710, 1939. *In Russian.*—It is shown that a superconducting tin ellipsoid in the intermediate state has anisotropic conductivity, as was previously shown for a sphere by Shubnikov and the author. The curves showing the maximum current in the superconducting state as a function of applied field agree with Shubnikov's rule for a ring [see Abstract 845 (1937)], and curves for the case when the ellipsoid is in the intermediate state were also measured. D. S.

227. Electrical conduction of commercial boron crystals. J. H. Bruce and A. Hickling. *Faraday Soc., Trans.*, **35**, *pp.* 1436–1439, *Dec.*, 1939.—Observations with d.c. and a.c. on the conduction of electricity in boron crystals are described. It is shown that, after a preliminary burning-in process, the state of negative resistance is fully developed in a very short period, and that the results for any given crystal show a high degree of self-consistency, and it is suggested that the existing theory of the process is inadequate for their description. Authors.

See also Abstracts 14, 129, 277, 285.

DIELECTRICS AND CAPACITANCE.

228. Internal rotation in 1, 1, 2-trichloroethane. A. Turkevich and J. Y. Beach. *Am. Chem. Soc., J.*, **61**, *pp.* 3127–3130, *Nov.*, 1939.—From an electron diffraction investigation it has been shown that 1,1,2-trichloroethane is not a rigid molecule in the *cis* or the *trans* configuration, nor does it have a sinusoidal potential barrier to internal rotation with the *trans* configuration the most stable. The most stable configuration is rotated about 50° from the *trans* position. A potential barrier calculated from electrostatic (dipole) and exchange interactions is in agreement with the experiments. The C-Cl distance is $1{\cdot}75 \pm 0{\cdot}03$ Å. The Cl-C-Cl angle is $111° 30 \pm 2°$. The C-C and C-H distances were assumed to be 1·54 and 1·09 Å, respectively. [See Abstract 1779 (1939).] Authors.

229. Dipole moments and structures of O_3, $SiHBr_3$ and GeH_2Cl_2. G. L. Lewis and C. P. Smyth. *Am. Chem. Soc., J.*, **61**, *pp.* 3063–3066, *Nov.*, 1939.—The dipole moment of O_3 has been measured in solution in liquid O_2. It indicates that the molecule is a bent structure with a very obtuse angle between the bonds of two O atoms attached to a central atom. These two identical bonds have some polar character as a result of resonance among forms containing semi-polar bonds. The moments of silicobromoform and dichlorogermane, measured in heptane and CCl_4 solutions, respectively, show that Si compounds tends to have minimum moments in the group of C, Si, Ge and Sn compounds, which, otherwise, increase in the order named. Authors.

230. Dipole moments and structures of certain nitro-compounds and amines. G. L. Lewis and C. P. Smyth. *Am. Chem. Soc., J.*. **61**, *pp* 3067–3070. *Nov.*, 1939.—The dipole moments of tetranitromethane, nitroform and nitrogen pentoxide have been determined in CCl_4 solution and those of cyclohexylamine and morpholine have been measured in benzene solution. Tetranitromethane is concluded to have a large atomic polarization but zero dipole moment, which means that it is not trinitromethyl nitrite as sometimes suggested. The moment of nitroform is consistent with its tetrahedral structure, inductive effects in the molecule being smaller than those in chloroform, probably because of the lower polarizability of the atoms and of a staggering of the nitro-groups in their rotation around their bonds to the central C atom. The moment of cyclohexylamine is of the same size as those of the primary alkyl amines, as it should be. The moment of morpholine shows that it exists primarily in the Z- or chair-shaped forms of the molecule. Authors.

231. Relations between electrostatic potentials and reaction velocities. H. O. Jenkins. *Chem. Soc., J., pp.* 1780–1787, *Nov.*, 1939.—In the alkaline hydrolysis of a series of benzoic esters, a linear relation has been discovered between the energy of activation and the electrostatic potential at the C atom to which the carbethoxy-group is attached. The slope of the line is approximately given by *Ne*, Faraday's constant, where *N* is the Avogadro number, and *e* is the electronic charge, thus offering a real proof that the electrical interpretation of the reaction is the correct one. Reactions are discussed in which the permanent mesomeric effect is directly proportional to the inductive effect. AUTHOR.

232. Polarizations and related data of optically active and racemic β-octanol. J. B. M. COPPOCK AND F. R. GOSS. *Chem. Soc., J., pp.* 1789–1792, *Nov.,* 1939.—Determinations of the density, dielectric constant, molecular polarization, and partial polarization in benzene solution of *d*-, *l*-, and *dl*-β-octanol reveal no difference between the active and the racemic forms. These results are in agreement with the view that *dl*-β-octanol is simply a racemic mixture. It is shown that the hygroscopic nature of the carbinol leads to anomalous results for the moist material, and the need for the careful exclusion of water in the measurements described in emphasised. The apparent dipole moment of β-octanol in benzene solution is 1·66 D. AUTHORS.

233. Electrical breakdown strength of ionic crystals as a function of temperature. R. C. BUEHL AND A. V. HIPPEL. *Phys. Rev.*, **56,** *pp.* 941–947, *Nov.* 1, 1939.—It has been generally believed that the breakdown strength of an insulator is *constant* in the lower temperature and decreases rapidly at high temperatures, indicating thermal breakdown. The authors show that, at least in ionic crystals like KBr, a very steep *increase* of breakdown strength with temperature is recorded in the lower range. This new phenomenon in insulators is apparently analogous to the temperature coefficient of the resistance in metals. It affords a decision between the different theories of breakdown proposed. AUTHORS.

***234. Condenser for testing liquid dielectrics.** L. HARTSHORN AND E. RUSHTON. *Journ. Sci. Instruments*, **16,** *pp.* 366–368, *Dec.*, 1939.—The condenser described is one that can be evacuated, filled with dry air, or with a liquid, for the purpose of measurements of dielectric constant and power factor. It is of the cylindrical type, with solid metal electrodes, either platinum- or rhodium-plated, and insulated by means of a single collar of fused quartz. The special features are : rigidity, ease of cleaning, the small volume of liquid required (15 ml.), high insulation resistance, and very low residual inductance and power factor. It is suitable for measurements at radio frequencies, up to say 20 Mc./s. as well as for d.c. and l.f. tests. AUTHORS.

See also Abstracts 50, 182.

ELECTROCHEMISTRY.

235. Rôle of electrons in the Daniell cell. V. KARPEN. *Comptes Rendus*, **209,** *pp.* 509–511, *Sept.* 25, 1939.—Further consideration [see Abstract 4384 (1939)] is given in this paper to the necessity of introducing the part played by the electrons in calculating the e.m.f. of contact in Daniell cells. The e.m.f. of the cell is $V_e - V_s + V_s$; $E = RT \log (\Sigma'_s + 2x_s)/(\Sigma'_e + 2x_e)$. This formula is applicable to all cells. The impossibility of statistical equilibrium between the corpuscles of a metal and of an electrolyte in contact, and the establishment of the permanent regime as previously noted are proved. J. J. S.

236. Electrolytic preparation of molybdenum phosphides. J. L. ANDRIEUX AND M. CHÊNE. *Comptes Rendus*, **209,** *pp.* 672–674, *Nov.* 6, 1939.—On electrolyzing a bath of MoO_3 dissolved in molten ($NaPO_3$+ NaCl) at 800° C., crystalline products are obtained, containing 75·6 –

90·3% Mo, and 24·4 − 9·7% P, later MoO_2. Below 4% MoO_3 the composition corresponds to MoP and above 11% to Mo_3P. D. R. H.

237. Second ionization constant of oxalic acid. H. S. HARNED AND L. D. FALLON. *Am. Chem. Soc., J.*, **61,** *pp.* 3111–3113, *Nov.*, 1939.—By means of suitable cells without liquid junction, the second ionization constant of oxalic acid, K_2, has been determined at 5° intervals from 0 to 50°. The equation $\log K_2 = 5{\cdot}771 - 0{\cdot}000\,816t - 6 \times 10^{-5}\, t^2$ expresses the observed values of $\log K_2$ with an average accuracy of $\pm 0{\cdot}001$. Values of the heat content and heat capacity of the ionization reaction have been tabulated. AUTHORS.

238. Transference numbers of HCl in water and dioxane-water mixtures. H. S. HARNED AND E. C. DREBY. *Am. Chem. Soc., J.*, **61,** *pp.* 3113–3120, *Nov.*, 1939.—E.m.f.'s of the cells Ag-AgCl | HCl (*m*), dioxane (*X*), H_2O (Y) | HCl(*r*), dioxane (X), H_2O (Y) | AgCl-Ag have been obtained for 0, 20, 45, 70 and 82% dioxane solutions at 5° intervals from 0 to 50° and from 0·005 to 3·0 *M* acid concentration. The cation transference number has been calculated over these ranges of temperature and concentration from these results and previous measurements of the cells without liquid junction. The limiting transference number has been determined by extrapolation for all the solutions over the entire temperature range. Agreement with the limiting law of the Onsager conductance theory was observed in the water, 20, 45 and 70% dioxane-water mixtures. Results obtained with the mixtures containing 82% dioxane were less accurate. They have a value, however, since no transference number data in media of as low a dielectric constant ($D_{25} = 9{\cdot}57$) are available. [See Abstract 1810 (1937).] AUTHORS.

***239. Electrolytic cells.** M. RANDALL. *Am. Phys. Teacher*, **7,** *pp.* 292–314, *Oct.*, 1939.—A general account. W. R. A.

See also Abstracts 231, 250.

ELECTRONS, NEUTRONS, POSITRONS AND PROTONS.

240. Neutral mesotrons and electron pairs. J. SOLOMON. *Comptes Rendus*, **209,** *pp.* 678–680, *Nov.* 6, 1939.—It is shown that the theory of nuclear forces of Gamow, which is based on a consideration of electron pairs, is contained in the theory of the neutral mesotron in its general form. The disintegration of a neutral mesotron into a pair of electrons is considered. It is indicated that a neutral mesotron possesses a pair field surrounding it. G. O. B.

241. Proca potential. D. IVANENKO AND V. RODICHEV. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9,** 5, *pp.* 526–531, 1939. *In Russian.*—A number of classical problems can be discussed with the help of the Proca-Yukawa potential. Using the virial theorem the problem of the deuteron is discussed and an upper limit of about 700 electronic masses is deduced for the mass of the heavy electron. D. S.

242. Critical conditions in neutron multiplication. R. PEIERLS. *Cambridge Phil. Soc., Proc.*, **35,** *pp.* 610–615, *Oct.*, 1939.—The multiplication of neutrons is mathematically treated in the simplified case in which the cross-sections for absorption multiplication, and scattering are independent of the neutron energy. For this, strongly idealized, case the critical size of a sphere, i.e. the size at which the presence of a few neutrons would lead to an explosion, is approximately determined. R. P.

243. Electron reflection from photo-active surfaces. A. Ravdel. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 5, *pp.* 551–554, 1939. *In Russian.*—Experiments are described on the total reflection of electrons from photo-active surfaces both with and without illumination. D. S.

244. Diffraction of slow electrons by an Al single crystal. A. Rylov. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 6, *pp.* 670–680, 1939. *In Russian.*—The diffraction of slow electrons (10-150 V) from an Al crystal at a constant angle of incidence was investigated as a function of voltage. For a scattering angle of 26°, 14 diffraction maxima, and for angles 7° and 45°, 22 maxima, were found. The positions of these maxima could not be explained by the Bragg formula and are analogous to the so-called fine structure observed by Farnsworth [see Abstract 2864 (1936)]. The voltages at which the maxima occurred were found to be proportional to the squares of the odd numbers, and the difference of the wave vectors of the incident and diffracted beams was found to be independent of the angle of incidence for any given maximum. The effect of increasing the temperature of the crystal was studied up to 200° C., and found to decrease the intensity of diffraction. [See also Abstract 929 (1929).] D. S.

245. Scattering of neutrons from the C + D reaction. E. Amaldi, D. Bocciarelli, F. Rasetti and G. C. Trabacchi. *Phys. Rev.*, **56**, *pp.* 881–884, *Nov.* 1, 1939.—The scattering cross-section for neutrons emitted by bombarding carbon with 600-ekV deuterons was measured for 39 elements. Authors.

246. Effects of shape of potential-energy wells detectable by experiments on proton-proton scattering. L. E. Hoisington, S. S. Share and G. Breit. *Phys. Rev.*, **56**, *pp.* 884–890, *Nov.* 1, 1939.—The shapes of several types of potential wells giving approximate agreement with proton-proton scattering experiments are discussed. The somewhat poor agreement of the K_0, E curve for the exponential well with experimental data is shown to be due to the " tail " of the well at large radii. In the case of the meson potential well the effect of very large values of the potential at small distances counteracts the effect of the tail. The experimental dependence of phase shift on energy is not reproduced by the inverse square potential well. The maximum theoretically admissible depth of this potential fits experiment at about 1 eMV. A series expansion is developed which gives the change of the phase shift caused by a given change in the potential well, and an example of the use of the formula is given. The approximate equality of the proton-proton and proton-neutron interactions is discussed, and the close agreement in the case of the meson potential is shown to be due to the large attraction at small distances. Authors.

247. Distribution of energy of secondary electrons at low temperature. A. Bojinesco. *Comptes Rendus*, **209**, *pp.* 512–513, *Sept.* 25, 1939.—The distribution of energy of secondary electrons was studied in the case of Al at ordinary temperature and also at the temperature of liquid O_2. A target made of a sheet of Al on which was deposited by evaporation another layer of He was bombarded by primary electrons of energy 300 eV. Three groups of emitted electrons were found: (*a*) a group of fast electrons, few in number, probably primary electrons reflected elastically; (*b*) a group of electrons of energy between 280 eV and 45 eV, primary electrons scattered by metallic atoms with loss of velocity; (*c*) a group of very numerous slow electrons with energies between 45 eV and zero, for which a new process of formation must be sought. It is only electrons of the last group which can be considered as true secondary electrons. The number of the secondary electrons in the region from zero to 45 eV is much smaller at low temperatures than at ordinary temperature. J. J. S.

***248. Magnetic electron mirror.** V. KELMAN, M. KORSUNSKIJ AND F. LANGE. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 6, *pp.* 681–684, 1939. *In Russian.*—A magnetic electron mirror is described suitable for focusing a beam of variable energy. It is shown that the optical analogue of this mirror is a system of two cylindrical lenses and a mirror. D. S.

See also Abstracts 13, 29, 138, 223, 278.

ELECTROSTATICS.

249. Electrification of powders by free fall. G. MORRIS. *Phys. Soc., Proc.*, **51**, *pp.* 1010–1013, *Nov.*, 1939.—The electrification of insulating powders due to free fall has been examined quantitatively. For a given powder the quantity of electricity generated is found to be proportional to the square root of the product of the height of fall and the weight of powder. It is independent of the nature of the surface of the receiving vessel, and of the capacitance of the measuring system. Under given conditions of fall the quantity of electricity generated increases rapidly as the fineness of the powder is increased. AUTHOR.

250. Electrochemical potentials and Volta effect. Part I. O. SCARPA. *Accad. Lincei, Atti*, **29**, *pp.* 441–451, *May* 6, 1939. *N. Cimento*, **16**, *pp.* 281–293, *June*, 1939.—The values of the electrochemical potentials of the metals have been calculated by taking into account the contact potentials between the metallic conductors used in the circuit. The values so obtained differ considerably from those previously accepted. The order in which the metals follow each other in the series of electrochemical potentials can, however, be maintained. It is shown that a contact potential exists between the hydrogenated Pt and the non-hydrogenated Pt which are in contact in the H_2-electrode, and that it is of the order of 0·5 V. The new electrochemical potentials are tabulated; as in the old series the potential of the H_2-electrode lies between Pb and Cu. L. K.

See also Abstract 235.

MAGNETISM AND ELECTROMAGNETISM.

251. Ferromagnetism of impurity-semiconductors. T. MUTO. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 920, *pp.* 271–280, *Sept.*, 1939.—Pyrrhotite, magnetite and chromium-sulphur crystals do not show the same relation between saturation intensity of magnetization and temperature as Fe, Ni or Co. Experimental evidence suggests that the difference is due to a small excess of S atoms. By means of a simple modification of Wilson's impurity type model, the ferromagnetic behaviour of such "impurity-semiconductors" is examined by quantum mechanics and results are obtained in qualitative agreement with those of experiment. H. J. H. S.

252. Magnetic studies of solid solutions. Part I. F. BITTER AND A. R. KAUFMANN. *Phys. Rev.*, **56**, *pp.* 1044–1051, *Nov.* 15, 1939.—This paper represents the first step in an extended programme whose aim is the investigation of solid solutions with special reference to the structures that may be formed by heat treatment and plastic deformation. It is hoped to include eventually observations in high fields (100 000 gauss) and at low temperatures. The present work deals with observations up to 40 000 gauss and temperatures ranging from 20° to 1 000° C. The man-

ner of observation and reliability of the results is described in some detail. A series of observations on alloys of Cu containing up to 0·7% Fe are reported. Up to about 4% Fe can be put into solution in Cu at high temperatures, but the solubility decreases to an exceedingly small value at room temperature. Observations indicate that Fe atoms in solution in Cu retain a permanent magnetic moment of approximately 3·5 Bohr magnetons, and obey a Curie-Weiss law at high temperatures, the Curie temperature of an alloy containing 0·7% Fe by weight being 150°K. The solution seems to be sluggish and can be greatly supercooled. The manner of precipitation from solution appears to be fairly complex, and the results are being tentatively interpreted as follows: First there is a rearrangement of the atoms in the solution followed by the precipitation of a non-magnetic phase which can be converted into a ferromagnetic phase by cold work. This ferromagnetic phase can be made to grow thermally, but apparently does not form readily of its own accord.
AUTHORS.

253. Energy of magnetic anisotropy of a ferromagnetic cooled in a magnetic field. S. VONSOVSKIJ. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 6, *pp.* 702–707, 1939. *In Russian.*—The energy of magnetic anisotropy of a ferromagnetic cooled in " weak " (region of inversion) and " strong " (region of rotation) magnetic fields is calculated on the basis of Bozorth's theory [see Abstract 5106 (1937)]. The effect of cooling in a magnetic field on the "critical" field (for which the magnetization curve becomes irreversible) is also calculated. D. S.

254. Magnetism and molecular constitution of some manganese compounds. S. S. BHATNAGAR, B. PRAKASH AND J. C. MAHESHWARI. *Indian Acad. Sci., Proc. Sect. A*, **10**, *pp.* 150–155, *Sept.*, 1939.—Using the modified Gouy balance, the magnetic specific susceptibilities, χ, of the pink (I) and green (II) crystalline manganohalides of C_5H_5N (obtained by interaction of hydrated $MnCl_2$ with C_5H_5N in concentrated pure HCl), potassium manganichloride (III), silver permanganate (IV), and potassium manganicyanide (V), have been measured in the solid state. The susceptibility tube was packed by centrifuging and access of air was avoided for (V) by means of a protective layer of 10% aqueous KCN over the packing. The experimental value of $55 \cdot 8 \times 10^{-6}$ for the χ of (I) compares with the theoretical value $56 \cdot 4 \times 10^{-6}$ calculated on the Bose-Stoner formula for Mn after the necessary corrections had been made for the presence of other groups in the formula $MnCl_2 \cdot C_5H_5NHCl.H_2O$ proposed by Taylor. The experimental and theoretical χ values of (II) are $41 \cdot 29 \times 10^{-6}$ and $17 \cdot 20$ (Reitzenstein's formula $MnCl_4 \cdot 2C_5H_5N$) or $40 \cdot 84 \times 10^{-6}$ (Taylor, $MnCl_4 \cdot (C_5H_5NH)_2$), indicating the correctness of the latter formula. The magnetic data ($\chi = 18 \cdot 05 \times 10^{-6}$) support the idea of $Mn^{\cdots\cdot}$ in (III), the calculated value being $17 \cdot 8 \times 10^{-6}$, and the formula is therefore K_2MnCl_6. Septavalent Mn predicts for (IV) temperature-independent dia- or weak paramagnetism. The experimental χ value of $-0 \cdot 28 \times 10^{-6}$ agrees with this, and indicates $AgMnO_4$. The χ value of (V) is $4 \cdot 0 \pm 1 \cdot 0 \times 10^{-6}$. Conclusions cannot accurately be drawn as to the structure of this compound since, as the measured product was moist, the χ value is only approximate. The product is probably an impure specimen of $K_5[Mn(CN)_6]$ contaminated with $K_3[Mn(CN)_4]$. W. R. A.

255. Antiferromagnetism in some manganese compounds. C. F. SQUIRE. *Phys. Rev.*, **56**, *pp.* 922–925, *Nov.* 1, 1939.—The temperature dependence (300° K. to 40° K.) of the magnetic susceptibility of the following Mn^{++} salts has been measured: MnO, MnS, MnSe, MnTe. A λ-point transition at low temperatures makes the susceptibility break away from a Weiss-Curie law and decrease with lowering temperatures. Each salt has its characteristic transition temperature, increasing with increasing molecular weight. Evidence for field dependence of the susceptibility and for magnetic hysteresis has been found. It seems likely that an exchange force is the cause of the transition from paramagnetism to antiferromagnetism. Author.

256. Magnetic susceptibilities of some cupric salts. J. Reekie. *Roy. Soc., Proc. A*, **173**, *pp.* 367–378, *Dec.* 18, 1939.—The mean mass susceptibilities of the three cupric salts, copper-sulphate pentahydrate, copper-potassium-sulphate hexahydrate, and copper-ammonium-sulphate hexahydrate have been measured down to a temperature of 1·6° K. It is found that the first salt follows approximately a Weiss law with $\theta = -0{\cdot}7°$ over the whole temperature range, and that both double sulphates follow a similar law with $\theta = -0{\cdot}3°$ down to 14° K. but obey a simple Curie law in the He region. The results are compared with Jordahl's crystalline field theory in which the Cu^{++} ion in these salts is assumed to be acted upon by an electrostatic field of nearly cubic symmetry. It is concluded that Jordahl's theory is able satisfactorily to account for the observed variation with temperature of the effective magnetic moment of the Cu^{++} ion in the double sulphates, but that in the case of the copper sulphate the theory is not adequate to explain the susceptibility measurements. It appears that either the system of energy levels of the Cu^{+++} ion in copper sulphate must differ considerably from that in the double sulphates, or magnetic interaction effects must become appreciable in copper sulphate at a relatively high temperature. Author.

257. Low-temperature magnetic susceptibility of beryllium bronze. I. Saveljev and L. Vereschagin. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 5, *p.* 638, 1939. *In Russian.*—The magnetic susceptibility χ of a beryllium bronze (98·5% Cu + 1·5% Be) was measured at various temperatures from 77° K. down to 14° K. by means of a Sucksmith balance. χ (per gm.) varied from $1{\cdot}2 \times 10^{-7}$ at 77° K. to $5{\cdot}2 \times 10^{-7}$ at 14·0° K. D. S.

258. Magnetic properties of ethyl-isocyanide-ferrohemoglobin and imidazole-hemoglobin. C. D. Russell and L. Pauling. *Nat. Acad. Sci., Proc.*, **25**, *pp.* 517–522, *Oct.*, 1939.—Ethyl-isocyanide combines easily with ferrohemoglobin to give a compound with an absorption spectrum consisting of two narrow bands at about 5 540 and 5 250 Å. The substance is completely diamagnetic, and contains no electrons with unpaired spins. Its structure is analogous to those proposed for the other ferrohemoglobin compounds. The imidazole combines with ferrihemoglobin to form a compound with spectrum differing little from that of ferrihemoglobin hydroxide. Three values of molal susceptibility were found corresponding to 2·66, 2·29 and 1·76 Bohr magnetons. These indicate the presence of one unpaired electron per heme, with orbital and spin moments. Details are given. G. E. A.

259. Magnetic measurements on hexaphenyldigermane. P. W. Selwood. *Am. Chem. Soc., J.*, **61**, *pp.* 3168–3169, *Nov.*, 1939.—Magnetic measurements on hexaphenyldigermane set upper limits of dissociation at 1% in the solid and 20% in a nearly saturated benzene solution at 25°. It is considered improbable that any dissociation takes place under these conditions. Author.

260. Non-adiabatic processes in an oscillating magnetic field. P. Caldirola. *N. Cimento*, **16**, *pp.* 242–252, *May*, 1939.—The behaviour of a system with a given angular and magnetic momentum in the presence of a constant magnetic field and a superimposed weak oscillating field is studied. This corresponds to the conditions which arise in the atomic beam method of Rabi and others [see Abstract 3678 (1939)]. The analysis is carried to a higher order of approximation than Rabi's but the differences are insignificant. The present method predicts also a rather unusual resonance effect when the frequency of oscillation is about a third of that of precession, but an experimental verification of this effect seems practically impossible. R. P.

261. Damping correction in mutual inductance circuit. P. L. Bayley and K. B. Shiffert. *Am. Phys. Teacher*, 7, *pp.* 339–342, *Oct.*, 1939.—The initial throw of a ballistic galvanometer in the secondary circuit caused by a reversal of current in the primary circuit is not strictly inversely proportional to the resistance of the secondary circuit. An exact correction factor is developed and is found to equal $e^{(\lambda/\pi)\tan^{-1}(\pi/\lambda)}$. A table of values is given and the factor is checked experimentally. L. E.

262. Effect of stress on hysteresis of even-order magnetic effects. K. Belov. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 6, *pp.* 685–694, 1939. *In Russian.*—An investigation is described of one of the even-order magnetic effects (the Thomson-Nernst effect) for the irreversible part of the hysteresis loop, and under the influence of tension and torsion. Materials with both positive and negative magnetostriction were used, and the results could be explained by Akulov's theory of the magnetization process of ferromagnetics. [See Abstract 1725 (1934) and following Abstract.] D. S.

263. Influence of tension and torsion on even-order magnetic effects. K. Belov. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 6, *pp.* 695–701, 1939. *In Russian.*—By an extension of Akulov's theory a theoretical curve of the Thomson-Nernst effect (as typical of an even-order effect) as a function of the magnetization is obtained, and found to agree well with the experimental data [see preceding Abstract]. D. S.

See also Abstracts 17, 138, 139, 260.

MEDICAL RADIOLOGY AND ELECTROLOGY.

264. Teleroentgen kymography. H. E. Ungerleider and R. Gubner. *Radiology*, **33**, *pp.* 497–507, *Oct.*, 1939.—For some years now, X-ray kymography has been used for the qualitative examination of heart movements, but quantitative interpretations have not been possible owing to the distortion of the image arising from comparatively short focal distances. In the present work, the use of a large capacity tube and a 3-phase generator has made exposures at 2 m. focal distance possible (1·5 sec. with 125 mA at 80 to 85 kV). The more accurate cardiac images obtained have made possible measurements of heart size and output. Two methods of determining cardiac output are described ; in the first the heart volume changes from systole to diastole are measured directly from lateral and antero-posterier exposures. The second is a modification of the Broemser-Ranke method. It is further suggested that the results obtained may be useful in the estimation of aortic-elasticity. J. E. R.

265. Analysis of laminagraphic motions and their values. J. Kieffer. *Radiology*, **33**, *pp.* 560–585, *Nov.*, 1939.—The motions usable for body-section röntgenography are discussed. The importance of the proper evaluation of sharpness and depth of focus are stressed. Rectilinear, sine, circular, and spiral movements are analyzed and their values and drawbacks described. It is shown that, unfortunately, no single type of movement is best for all röntgenographic problems; that rectilinear motion is simplest but may give fallacious results; that sine motion is useful for a few body parts; that spiral motion is best for the majority of cases, and that the value of circular motion lies mostly in elasticity of exposure though it is also valuable when great depths of focus are desired. An attempt is made to evaluate body-section röntgenography on the premise that "a satisfactory röntgenographic study should give the maximum positive information consistent with the absence of false information and that this can be achieved only by making the proper compromises."

AUTHOR.

266. Radiographic depth localization of foreign bodies. K. C. CLARK. *Radiography*, **5**, *pp.* 195–211, *Nov.*, 1939.—A description of established localization methods. Routine radiography is in flat projection, i.e. in two dimensions. Localization requires radiographic investigation in *three* dimensions as in stereography. Most localization methods utilize the data derived from two or more shadows of the foreign body produced on a screen or films by the displacement of the tube between two exposures. This is the basis of the similar triangles localization or triangulation method, on which the majority of localization methods depend. Other methods depend on parallax, i.e. the apparent change of position of an object relatively to other objects when viewed from different places. Each method provides (*a*) marking the skin surface immediately above the foreign body and (*b*) marking the depth of the foreign body below the skin and from a given skin level. The following methods are summarized: (1) Screen only A.M.D. localizer incorporates the use of a special pointer panel placed between the tube and patient and a specially marked fluorescent screen. (2) Screen and film (*a*) similar triangles method; (*b*) parallax method. (3) Film only—similar triangles localization when screening facilities are not available. (4) Eye localization. It is urged that precise localization of depth is essential immediately before operation and preferably with the patient in the operating position, when after viewing preliminary films the surgeon has indicated the probable surgical route for the extraction of the foreign body. All the factors involved, namely, the patient, screening precautions, the foreign body apparatus—both general and specific, exposure processing, geometrical principles concerned, and initial instructional work on models are reviewed in detail. T. A. C.

***267. Radiological localization of foreign bodies.** D. B. McGRIGOR. *Brit. J. of Radiology*, **12**, *pp.* 619–631, *Nov.*, 1939.—The paper consists of a comprehensive survey of the methods available to deal with the radiological problems occasioned by the traumatic surgery and medicine of war. A series of general considerations arising from these problems is first put forward, together with a suggested foreign-body localization report. The main body of the paper is divided into four sections: (1) The basic principle of localization as illustrated by the Mackenzie Davidson cross-thread localizer; (2) similar-triangle localization with films, in its simplest form; (3) screen localization; (4) simple apparatus and method for localization in the orbital region. Each section contains a description of simple essential apparatus, together with the necessary charts and tables for use with the apparatus under standard conditions.

J. E. R.

268. Visualization of non-metallic foreign bodies. R. I. ROBERTS. *Brit. J. of Radiology*, **12**, *pp.* 680–685, *Dec.*, 1939.—A radiological study is made of non-metallic foreign bodies. Their visibility on the screen is discussed, and technical details are examined with regard to their radiographic demonstration. The investigation shows that visualization of such foreign bodies depends upon thickness, density, size, and character of the foreign body, and these properties have to be taken in conjunction with the thickness and density of the surrounding tissues. AUTHOR.

269. Limitations of kymography. F. ROBERTS. *Brit. J. of Radiology*, **12**, *pp.* 638–644, *Nov.*, 1939.—The limitations of kymography, though not generally realized, are chiefly due to inadequate appreciation of the geometry of the moving shadow. Within certain limitations the kymograph is of value in determining the systolic and diastolic size of the heart and in the diagnosis of some thoracic conditions. Only in the rare circumstances when the movements to be observed are exactly parallel with the kymograph slits are the serrations of the kymogram capable of accurate and rational interpretation. Under other conditions they may lead to inaccurate and sometimes absurd results. In the kymoscope, in which the kymogram is observed through a series of moving slits, the conditions at the time of exposure are reproduced and the results became quite reliable, and in some ways are preferable to those of the X-ray cinematograph.

J. E. R.

270. Action of radiations on bacterium coli. S. LURIA. *Comptes Rendus*, **209**, *pp.* 604–606, *Oct.* 16, 1939.—Many workers investigating the action of radiations on bacterium coli have found the mortality curve to be a simple exponential $N/N_0 = \epsilon^{-\alpha D}$, indicating that a single hit on a sensitive zone is sufficient to kill a bacterium. These experiments have been repeated with α-particles from Po and K_α radiation from Mo. In the case of the α-particle irradiation the mortality curve is sensibly exponential, although doubt exists about points at the upper and lower ends of the curve. The X-ray curve varies considerably from the simple exponential and fits much better the formula $N/N_0 = \alpha D\epsilon^{-\alpha D}$, indicating that two impacts and not one are necessary for death. It is suggested that the discrepancy between these and previous results is due to inadequate statistical analysis by earlier workers. A close examination of the bacteria after irradiation reveals, in addition to the death of some of the germs, other changes indicating the presence of sub-lethal impacts. This, it is suggested, further complicates the simple theory previously accepted.

J. E. R.

271. Radium poisoning. J. READ. *Brit. J. of Radiology*, **12**, *pp.* 632–637, *Nov.*, 1939.—The danger of Ra poisoning has recently become a matter of importance because of the possibility of the scattering of Ra element by bombing. The literature on the subject has been surveyed and the results summarized. From a consideration of cases of Ra poisoning both experimental and accidental it is possible to obtain some idea of the distribution of the element in the various tissues when absorbed in different ways. Typical cases of poisoning are described, and particular attention is paid to the question of the retention of inhaled dust. The general conclusion is that about 100 μgm. by mouth or 50 μgm. inhaled would probably produce a permanent deposit of the order of 1 or 2 μgm,. a quantity which may be lethal. These quantities may be much less in the case of $RaSO_4$ which has a low water solubility, and this salt is therefore probably much more dangerous. A very comprehensive bibliography is attached. J. E. R.

272. γ-Ray measurement of radon. T. H. ODDIE. *Brit. J. of Radiology*, **12**, *pp*. 686–691, *Dec.*, 1939.—Experimental measurments have been made of the rise of γ-ray activity of freshly filled Rn sources. The effect on the measured activity of the following factors has been taken into account:—(*a*) the distance between the source and the measuring instrument; (*b*) the lead wall thickness of a cylindrical ionization chamber of 1-l. volume and brass lining; (*c*) the wall material and thickness of the Rn container, and (*d*) the thickness of the wooden source holder. Tables are given, suitable for interpolation, together with a method of calculating the Ra (B + C) content of a container at any time after filling. Results obtained with two different measuring instruments agree with each other and with those previously published by Slater, if the latter are corrected for absorption. The measured half-value period of Rn of 3·831 ± 0·006 days is also in agreement with other work. [See Abstract 4288 (1939).] AUTHOR.

***273. Radium beam therapy unit at the Western Infirmary, Glasgow.** A. A. CHARTERIS AND J. THOMSON. *Brit. J. of Radiology*, **12**, *pp*. 692–695, *Dec.*, 1939.—The authors describe the unit for Ra beam therapy recently installed at the Glasgow Western Infirmary. Although designed for amounts of Ra up to 10 gm., the apparatus has readily been adapted for temporary use with 3 gm. The way in which protection problems have been overcome is detailed, and it is shown that no member of the staff suffers significant exposure. AUTHORS.

***274. Cyclotron for biochemical research.** A. J. ALLEN, M. B. SAMPSON AND R. G. FRANKLIN. *Frank. Inst., J.*, **228**, *pp*. 543–561, *Nov.*, 1939.—Certain features of the cyclotron constructed by the Biochemical Research Foundation of the Franklin Institute, which may be of interest to those building a similar machine, are as follows: (1) The design and construction of the magnetic circuit. (2) Results of a survey of the magnetic field with and without "shimming." (3) The construction and dimensions of the vacuum tank and deflector. (4) The design of dee supports with a convenient arrangement for the adjustment of the dees. (5) Modified ion sources using tungsten ribbon filaments, one of which enables the cyclotron to deliver a current of at least 30 μA of deuterons at 11 eMV on an external target. (6) A high-frequency system for supplying voltage to the dees. AUTHORS.

275. Relative degrees of radiosensitivity of tissue. J. F. ELWARD AND J. F. BELAIR. *Radiology*, **33**, *pp*. 450–461, *Oct.*, 1939.—A review of the work published on this subject since Bergonié and Tribondeau in 1906 enunciated the principle that has since become law, that actively proliferating cells are peculiarly radiosensitive, also that the more embryonal the type of cell the greater its radiosensitivity, and the more differentiated and highly specialized the type of cell the greater its resistance. Among the methods for the complete sterilization of malignant cells are first, selective radiation and then caustic irradiation and a third method known as growth restraining, by production of fibrous tissue around the growth such as by intense interstitial Ra treatment. The question of specific effects of any wavelength of X-rays, difference between effects of β- and γ-rays of Ra, and the fractioning of dose are discussed. The Arndt-Schulz law, according to which small doses of X-rays and Ra rays stimulate and large doses depress cellular metabolism has received various interpretations. It is considered that radiotherapy is not solely the physical problem of the production of a homogenous field of radiation throughout the tumour but that the biologic condition of cells in different parts of the tumour is important. Repeated experiments have shown that the susceptibility of tumours to radiation agrees closely with the radiosensitiveness of normal cells of the same kind as those from which the tumours originated or of which they are largely composed making it possible to classify the majority in order of sensitivity. There are anomalies, however, and it is considered that these may be due to undiscovered biological factors which reveal no microscopic indication of their existence. T. A. C.

OSCILLATIONS AND WAVES.

***276. Variable oscillator for e.h.f. measurements.** R. KING. *Rev. Sci. Instruments*, **10**, *pp.* 325–331, *Nov.*, 1939.—The fundamental theory of coupled circuits with distributed constants is reviewed and applied to the problem of designing an oscillator for use in parallel line measurements. An oscillator having a continuously variable frequency range from 75 to 500 Mc./s., and which fulfils the theoretical requirements which permit the e.m.f. induced by it in a parallel line to be represented by point generators, is described. Its frequency characteristic is displayed, and its application to parallel-line measurements is discussed briefly. AUTHOR.

277. Absorption of h.f. energy by electrolytes. P. GULJAEV. *J. of Exp. and Theor. Phys. U.S.S.R.*, **9**, 6, *pp.* 760–762, 1939. *In Russian.*—The absorption by an electrolyte of the energy of h.f. waves of 6 and 9 m. tangential to the surface was investigated by measuring the rise of temperature. An empirical formula was found for the absorption in terms of the intensity of the waves, the conductivity of the electrolyte and the geometry of the experimental arrangement. D. S.

PHOTO-ELECTRICITY.

278. Auger and secondary X-ray electrons from gold. R. L. MAYO AND H. R. ROBINSON. *Roy. Soc., Proc. A*, **173**, *pp.* 192–200, *Nov.* 28, 1939.—Measurements have been made, in the magnetic spectrograph, of the energies and approximate relative intensities of the Auger electrons emitted by gold atoms which have been ionized in their L-levels. Material is obtained for a direct comparison of these energies with the energies of the X-ray electrons expelled by primary gold L-radiations from normal gold atoms. The analysis is, however, incomplete, and more powerful methods will be required to elucidate the complete Auger spectrum. A new value of h/e has been deduced from the results of the measurements on the X-ray electron groups. AUTHORS.

279. Sensitization of Sb-Cs photocathodes by S and Se. V. ZHUKOV. *J. Techn. Physics, U.S.S.R.*, **9**, 5, *pp.* 376–380, 1939. *In Russian.*—The preparation of Sb-Cs cathodes and their sensitization by a thin layer of S or Se (at room temperature) to give a maximum photo-electric effect is described. It was found that the integral sensitivity was increased by a factor which varied from 1·5 to 20 for different sample cathodes. The spectral sensitivity and the voltage-current characteristic were not appreciably changed by the sensitization. D. S.

280. Gas-filled photocells with reduced inertia. G. BELGOVSKIJ. *J. Techn. Phys. U.S.S.R.*, **9**, 5, *pp.* 381–388, 1939. *In Russian.*—The author describes experiments to reduce the inertia of gas-filled photocells by introducing extra electrodes (grids). D. S.

***281. Thallous sulphide photo-e.m.f. cell.** F. C. NIX AND A. W. TREPTOW. *J.O.S.A.*, **29**, *pp.* 457–462, *Nov.*, 1939.—A photo-e.m.f. effect is observed in Tl_2S produced by partial sulphurization of a Tl disc or of an evaporated Tl layer. The photosensitivity is observed to be as high as 6 000 × 10^{-6} A/lumen. Both open-circuit voltage and short-circuit current are observed in some cells to be directly proportional to the incident light intensity at all temperatures. In other cells, especially those displaying high photo-response, the open-circuit voltage and short-circuit current tend to saturate at high light intensities. The spectral photosensitivity curve possesses a maximum at 9 800 Å ± 200 Å with long- and short-wave thresholds at 15 000 and 6 500 Å, respectively. The short-circuit current *increases* with *decreasing* temperature down to about − 45° C., and then decreases continuously down to − 180° C. The position of the maximum varies somewhat from cell to cell. The photoelectric output of the cells when measured as a function of frequency of interruption of the incident light displays a recession of 75% at 20 000 c./s. AUTHORS.

282. Action of X-rays on semiconducting crystals. A. KRONHAUS. *J. Techn. Phys. U.S.S.R.*, **9**, 3, *pp.* 202–204, 1939. *In Russian*—Crystals of SiC, Sb_2S_3, and PbS were subjected to X-rays of varying wavelengths and intensities and the photo-electric current and change of resistance measured. There was no photo-electric current in the case of PbS, but all 3 semi-conductors showed resistance changes. D. S.

See also Abstract 243.

PIEZO-ELECTRICITY.

283. Absolute value of principal piezo-electric modulus of quartz. A. LANGEVIN. *Comptes Rendus*, **209**, *pp.* 627–630, *Oct.* 23, 1939.—Values of the principal piezo-electric modulus of quartz, determined by various observers range from 4·94 to 7·18 × 10^{-8} c.g.s. unit. This variation is shown to be attributable to the occurrence of crystallization in different directions (not detectable by optical methods) in the individual samples tested which gave a low value of the modulus. The value of the modulus, in the absence of this twinning from the sample examined, is slightly greater than 7 × 10^{-8} c.g.s. unit. J. S. G. T.

284. Activated water. G. PICCARDI. *Ricerca Scientifica*, **10**, *pp.* 813–820, *Sept.*, 1939.—A new phenomenon concerning the existence of activated water has been discovered. This activated water is produced by the simple contact of water with a piezo-electric dielectric. An apparatus is described whereby water is forced through a mass of piezo-electric crystal—quartz granules—under pressure. The following facts are recorded about the nature of the activation. It is not attained instantaneously, but when attained lasts for a long time—about 4 days. It is not lost by the freezing or distillation of the water. Two types of activation, designated as T and R can be obtained; the one accelerates and the other retards certain processes of precipitation and flocculation. Both types have biological effects. Great difficulties were experienced in the experiments owing to the natural radioactivity of water. It is also possible to activate, in this same manner, other liquids such as nitrobenzene. G. G.

THERMIONICS.

285. Oxide-coated cathodes. Part I. J. P. BLEWETT. *J. of Applied Physics*, **10**, *pp.* 668–679, *Oct.*, 1939.—After a short résumé of oxide-coated filament technique the thermal properties of the alkaline earth oxides are discussed under the following heads; (*a*) measurement of temperature, (*b*) emissivity, (*c*) thermal conductivity, and (*d*) rates of evaporation and vapour pressures. Useful tables and diagrams are given showing the important properties of Ba, Sr and Ca and their oxides. The electrical properties of the oxides are then dealt with under the heads: (*a*) electrical conductivity; theory of conductivity and thermionic emission, (*b*) thermoelectric effect, (*c*) ion emission and (*d*) behaviour of W filaments in BaO vapour. A. W.

286. Emissive and thermionic characteristics of uranium. W. L. Hole and R. W. Wright. *Phys. Rev.*, **56,** *pp.* 785–787, *Oct.* 15, 1939.—Certain properties of clean U *in vacuo* have been investigated. The following values were found: for emissivity below the melting point ($\lambda = 0\cdot67\mu$), 0·51; for thermionic work function, 3·27 ± 0·05 V, with a Richardson *A* of about 6; for melting point, 1 700° ± 25 deg. C.; for average coefficient of linear expansion, 25° C. to 1 000° C., 4×10^{-5}. Authors.

287. Thermionic and adsorptive properties of surfaces of tungsten single crystal. S. T. Martin. *Phys. Rev.*, **56,** *pp.* 947–959, *Nov.* 1, 1939.—The thermionic emission from a spherical tungsten single crystal has been observed. Photographs and diagrams show qualitatively the dependence of this emission on crystallographic direction. Nearly all the maxima and minima lie on a 110 zone. Similar observations have been made on the same crystal when Cs and Ba were adsorbed thereon. Adsorption forces are largest for Cs on surfaces of highest work function. For Ba the adsorption forces appear to be more dependent on surface structure as the force between the ion and its image contributes the major part of the adsorption energy. The behaviour of adsorption as a function of crystallographic direction is such that the sphere surface may be approximated by that which would be obtained by carving the sphere from a perfect lattice. There is no evidence for a faceted or step-like microstructure. Emission from the spherical crystal when Cs is adsorbing on contaminated complex surfaces is more complicated in its dependence on crystallographic direction than when the surface is clean, and a map of the emission over the crystal changes its configuration with temperature. This behaviour is not observed when the surface is clean or only slightly contaminated. Author.

THERMO-ELECTRICITY.

288. Critical examination of the Benedicks homogeneous thermoelectric effect. H. L. C. Ch'eng and W. Band. *Cambridge Phil. Soc., Proc.*, **35,** *pp.* 622–636, *Oct.*, 1939.—In a closed circuit of the same metal, in which there is an unsymmetrical temperature distribution, an e.m.f. is produced which is known as the Benedicks effect. The effect disappears if the material is spectroscopically pure and free of internal strains. In a specimen which shows the effect it disappears on annealing. If the specimen is kept at moderately high temperatures such as are necessary in order to measure the effect, fatigue is observed and the effect disappears in about a day. Unless the working temperature is too high, the specimen recovers completely after being kept at room temperature. There is also a temporary e.m.f. which arises while the temperature is being changed, and apparently is not subject to fatigue. This behaviour seems to be closely correlated with that of positive emission, which was observed on the same specimen, and the suggestion is therefore made that the two effects are related, and that the Benedicks effect is due to the inhomogeneity produced in the metal by the diffusion of ions as a result of positive emission. R. P.